Computerworld
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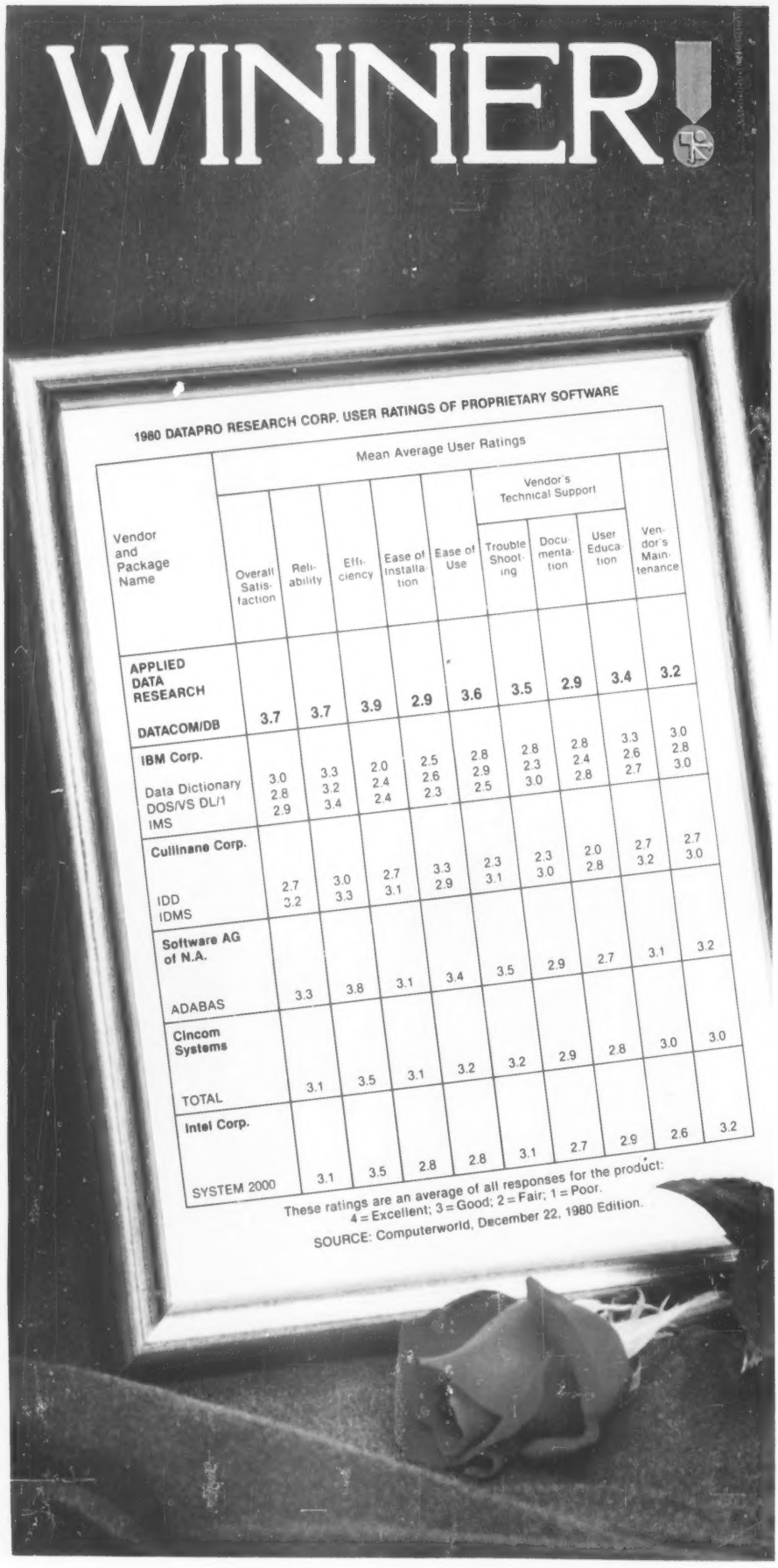

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						Vendor's Technical Support			
	Overall Satisfaction	Reliability	Efficiency	Ease of Installation	Ease of Use	Trouble Shooting	Documentation	User Education	Vendor's Maintenance
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IBM Corp.									
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DOS/VS DL/1	2.8	3.2	2.4	2.6	2.9	2.3	2.4	2.6	2.8
IMS	2.9	3.4	2.4	2.3	2.5	3.0	2.8	2.7	3.0
Cullinane Corp.									
IDD	2.7	3.0	2.7	3.3	2.3	2.3	2.0	2.7	2.7
IDMS	3.2	3.3	3.1	2.9	3.1	3.0	2.8	3.2	3.0
Software AG of N.A.									
ADABAS	3.3	3.8	3.1	3.4	3.5	2.9	2.7	3.1	3.2
Cincom Systems									
TOTAL	3.1	3.5	3.1	3.2	3.2	2.9	2.8	3.0	3.0
Intel Corp.									
SYSTEM 2000	3.1	3.5	2.8	2.8	3.1	2.7	2.9	2.6	3.2

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ON THE COVER: In this pre-1900 woodcut, the farmer applies a traditional tool to an age-old problem: reaping the greatest rewards for his labors. In information processing we turn to new tools to achieve the same goal: Productivity. Further enriching our technological tools are new techniques and methodologies to cultivate the greatest and oldest of resources: human skill and ingenuity. Equipped with new tools and human resources, we look forward to harvesting new bounties in systems productivity in the 1980s.

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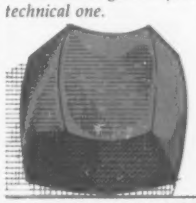

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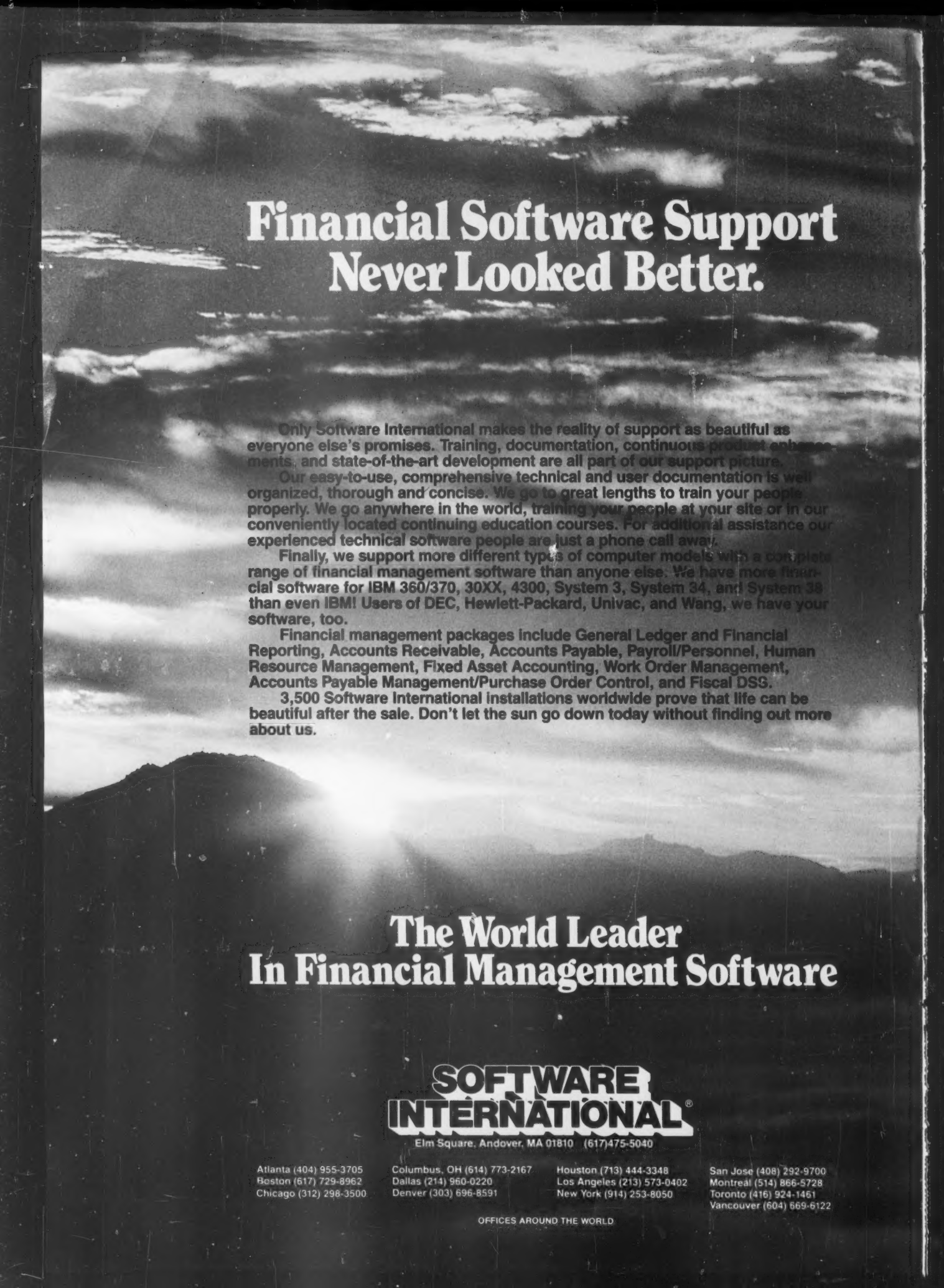
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OFFICES AROUND THE WORLD

By Richard G. Canning

THE CHALLENGE OF INCREASED PRODUCTIVITY

The need to increase the productivity of analysts and programmers is recognized by many data processing executives, in the face of a growing work load and a shortage of qualified development people. Also, the new office automation systems may be expected to pay their way through increased productivity of office staffs. In a broader context, company managements in the Western countries see the need to increase employee productivity in order to be more competitive with Japanese companies. Here is some interesting research on the motivation and management of computer personnel that may give some clues as to how significant productivity gains can come about.

Seeking Improved Productivity

With the growing Japanese dominance of such markets as automobiles, television, motorcycles and steel, it is becoming clear that the Japanese as a nation are doing a number of things better than other industrial countries. The U.S. has been accustomed to a leading role; now the Japanese have taken over in many major markets. And it is equally clear that this trend is continuing; Japan's competitor countries have not yet been able to turn things around.

Conventional wisdom is saying that the best answer to both tough competition from Japan and continued high inflation is to increase productivity. Get more units of output for the same number of units of input, say the adherents of the increased productivity theory, and balance will be reestablished.

However, the methods that are being used by the Western nations to increase productivity are not delivering gains of the magnitude needed. So it appears to us that competition from Japan and the problem of infla-

Photo: Lewis W. Hine George Eastman House

The Challenge of Increased Productivity

tion will force management to seek new ways for accomplishing the needed increases in productivity.

And what will these "new ways" be?

One answer is to look at Japan to find out what firms in that country are doing to increse their outputs and decrease their costs so dramatically. Spot the things that seem to have the greatest impact, then see what we can learn from those things.

Let us briefly describe, then, some of the main characteristics of the Japanese style of management, to see what might account for that country's competitive achievements.

The Japanese Management Style

The following brief discussion is based on a seminar given in Los Angeles last fall, under the auspices of the Southern California chapter of the Society for Management Information Systems (SMIS), a paper by Richard C. Beaird entitled "Industrial Democracy and Participative Management," (*Labor Issues of the '80s*, American Telephone and Telegraph Co., Basking Ridge , N.J.) plus a variety of other source materials, as well as several trips to Japan.

The SMIS seminar was on the subject "Applying Japanese management techniques to improve productivity," and included two executives of Japanese companies plus an executive of a U.S. company who has studied Japanese methods and uses them in his work.

The Japanese management methods appear to include the following four major components.

Create a "family" spirit. Japanese management seem to be very concerned for their employees — and as whole people, not just during their working hours.

Men are offered employment for a lifetime (meaning until age 55 or 58), as members of the corporate "family."

In the same way that a son would not be discharged from the family, a male employee is not discharged from the firm. In the same way that a parent visits a sick child in a hospital, a supervisor visits a sick employee. And in the same way that parents are proud of the accomplishments of their offspring, Japanese companies show their pride in their employees and the accomplishments of the employees.

In periods of bad times, the main concern is to save everyone's jobs, not just some jobs. If pay must be cut, the cuts start with (and are greatest at) the top.

If it makes no sense to produce products because there is no market for them, the employees are kept busy cleaning up the plant, fixing machines and so on.

In Japan, relatively large bonuses are paid each year and represent a large fraction of an employee's income; in recession times, however, the bonuses can be cut or eliminated — but the basic pay continues. Thus, "unemployment" pay in Japan is really paid by the companies, not by the government.

Unemployment is spread over all employees and is not limited to discharged employees, as in the Western world. Further, the employees retain their dignity and sense of family membership in recession periods.

If new machines and systems are brought into the firm, they are brought in to *help* the employees do their jobs, not to replace the employees — because typically employees are not fired and leave only when they retire.

Due to these long-term employment commitments, Japanese management must hire people very carefully, to make sure that they do not overcommit the company.

Another policy is to move people around the company, from department to department, over a period of years in order to expose them to more of the company's operations. Japanese management feels that this policy gives the employees a broader view of what the company is trying to do and helps build an emotional attachment to the company.

The net result of this policy of creating a family spirit is a sense of great loyalty both *by* the company (to the employees) and *to* the company (by the employees).

There is a price, however, that the employees pay; the company comes first and families come second, in the priority of things. But there is essentially no employee turnover.

Concern for quality. Japanese firms have developed an overriding concern for the quality of their products.

This concern has led to the widespread use of the interesting *quality circle* concept. Small groups of employees meet on company time to discuss and identify recurrent quality problems that they see or that have been pointed out to them.

Beaird says that the idea of quality control circles, or quality circles, really originated in the U.S. It was taken to Japan as a means of improving product quality during the days when Japanese quality was not so highly regarded as it is today. Now the concept is recognized as important in contributing to Japan's success.

Having identified a quality problem, the members of the quality circle try to trace it back to its source and then find ways to correct it. They seek to produce a product that everyone in the company can be proud of. In theory, every employee is a member of a quality circle and these discussions can be a regular part of each job.

Japanese executives feel that U.S. hiring-and-firing policies lead to high employee turnover, which in turn leads to poor product quality.

JDS Uncovers Attitude Problems

Employee attitudes and perceptions about their jobs play a very important role in productivity. The use of new computer technology, for instance, may not produce expected gains if employees are not motivated to use it effectively. The Hackman/Oldham Job Diagnostic Survey (JDS) is one questionnaire-type tool for uncovering employee job attitude problems.

The JDS was developed in the mid-'70s by J.R. Hackman (University of Illinois) and G.R. Oldham (Yale University). They established the validity of their instrument by testing more than 6,000 individuals performing over 500 different jobs at some 50 organizations. Since then, it has been used by a number of other people for studying employee job attitudes.

We talked with a data processing executive who used the JDS on a previous job. His previous employer is a facilities management firm, which manages the computer installations for a number of organizations around the country. The firm not only runs the computer operations, but performs application software development as well, at a number of dispersed sites.

Couger and Zawacki

This executive was familiar with the research being done by two professors at the University of Colorado — Professors Couger and Zawacki — on the use of the JDS to measure employee attitudes about their jobs.

He thought it was worth trying out and sold the idea to the president of the firm. Both he and the president *thought* that all was well, but they wanted to check on how the employees actually felt. Also, they wanted to be able to compare employee attitudes at their different sites.

The survey was administered by the data processing directors at each location. Couger provided counsel on the process via telephone. After the scores were tabulated and averaged, the results were delivered to the executive.

In brief, the study showed: (a) no major problems, (b) a few surprises and (c) employee attitudes about as management expected. The reasons for expecting these results were that the company was offering it employees positions with above-average challenges, had selected employees with above-average abilities and felt that it was providing the employees with above-average working conditions.

But the JDS turned up one point that required prompt attention. The programmer/analysts had strong negative feelings about the amount of system maintenance they had to do. Each programmer/analyst was totally responsible for one or more application systems and each was also trying to do new system development. But users were continually asking for changes and enhancements to existing systems — and the programmer/analysts felt trapped by these requests.

Management was, of course, aware of the problem; it is a common problem in the computer field. What they were not aware of was the strength of the negative feelings. So management's reaction, upon seeing the JDS results, was, "Let's get this thing cleaned up quickly."

The job changes that were made were not major redesigns, but rather minor adjustments. Each programmer/analyst still had primary responsibility for one or more application systems. But, in addition, he was now backed up by one or two other programmer/analysts who became the secondary resources for these systems.

So the maintenance work load for any application system could be and was shared among two or more programmer/analysts.

User Liaison

In addition, a user liaison position was created, to act as a buffer between the users and the programmer/analysts. Requests could be reviewed — and perhaps even handled — by the liaison person; only relevant requests flowed through to the programmer/analysts. Further, somewhat more formal procedures were imposed on the users for submitting these requests, to try to weed out some of the more spur-of-the-moment cases.

The executive left for his new job before having a chance to use the JDS again to measure the changes in programmer/analysts' attitudes. But he sees a big value for it in this role, even though (in his words) "it is no magic formula."

In most companies and at any point in time, he said, management is usually making a number of changes in an attempt to improve performance. The JDS provides a way of measuring employee attitudes *before* making a new set of changes, in order to establish a baseline for future reference. Then the JDS should be used periodically to measure changes in attitudes.

It is one way of providing quantitive feedback to management on the effectiveness of their changes. The executive demonstrated his belief in this point by arranging for the use of the JDS at his new firm.

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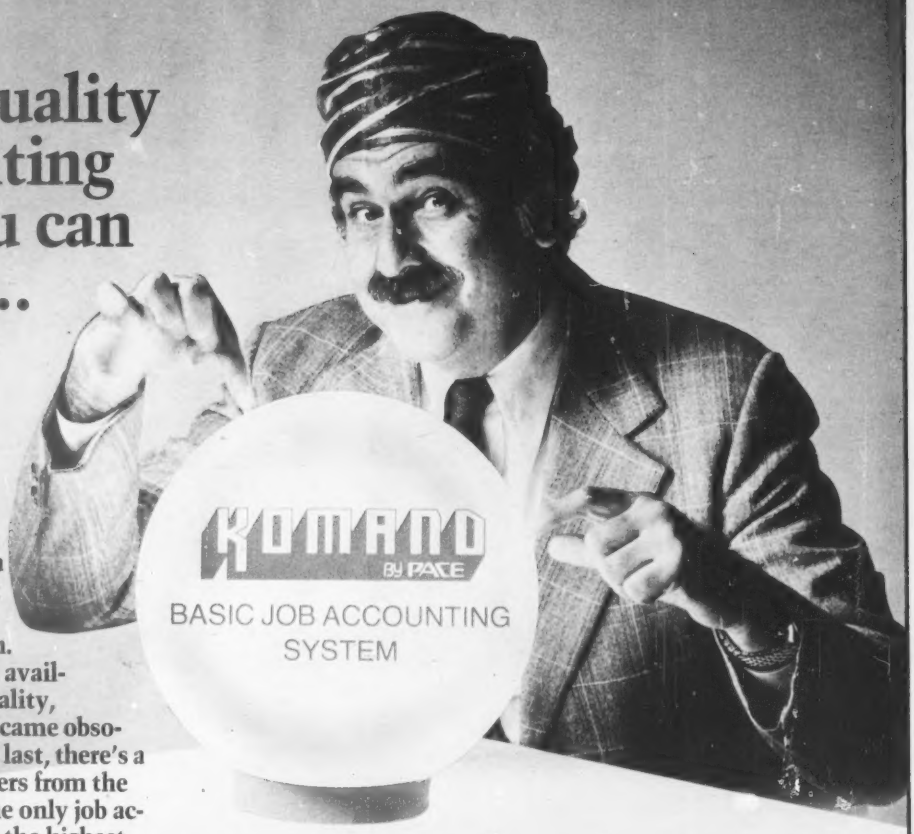

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The Challenge of Increased Productivity

Teamwork, not competition. Since employee turnover is very low (even in Japanese plants in countries outside of Japan) and expansion must be carefully controlled because of the long-term job commitments, there are not a lot of job openings on the managerial ladder.

This seems to lead to less competition among managers and more of a teamwork spirit.

Related to this teamwork is the concept of *consensus decision making*. Every person who is involved with a particular decision gets heard. Participants can "take sides" and members of the group try to persuade others to their view, so it can take a long time to make a decision. But once a decision is made, it is set; as one of the seminar speakers said, "A committed date is a sacred thing."

A corollary of this teamwork is *group responsibility*. No single person is acclaimed for an achievement; instead, the whole group is acclaimed. One speaker at the seminar said that if one department at his plant sets a record, the *whole plant* gets a celebration party.

Concern for the learning curve. The learning curve concept is well known in some U.S. industries, such as aerospace, but in general one does not hear it referred to often. The concept is simple; the more units of a product that are built, the less time and cost it takes to build each new unit because the people learn to do the job better.

The Japanese have adopted this idea with fervor. To them, volume is critical; more volume means greater learning and lower unit costs. So prices are often set based on these *expected* cost reductions.

This leads to lower prices and greater sales, so the policy tends to be self-fulfilling. As a greater and greater share of the market comes, so do the profits.

The key points. The overriding principle that comes through to us from these Japanese principles of management is: *they treat employees as human beings.*

Each employee is a part of the "family." Each person gets a chance to participate in company decision making — through the quality circle process, if not otherwise. This apparently has built a great sense of company loyalty in the employees.

(The Japanese do not have all the answers, in this regard. For instance, lifetime employment is still only for men. Women are hired on a more temporary basis, as a reflection of the oriental culture. The Japanese seem far behind the Western world in making effective use of the capabilities of women — and even the Western world has a long way to go in this regard.)

The next most important principle that comes through to us is: Increased productivity is a *by-product* of management policies; it is not a main goal. *Quality* is a main goal; *learning curve improvements* are a main goal. Out of these come productivity increases.

The upshot is this: The U.S. and other industrial countries are being outdistanced by the Japanese. The present rates of inflation in most industrial countries are really intolerable for healthy economies. Easy solutions and minor adjustments won't solve these problems. Something has to be done to achieve *substantial* increases in output for each unit of input. Management will be looking for effective solutions.

And where will these effective solutions be found? The answer is, we think, in the work environment. Competition and inflation will force major changes in management policies as they pertain to employees and their jobs.

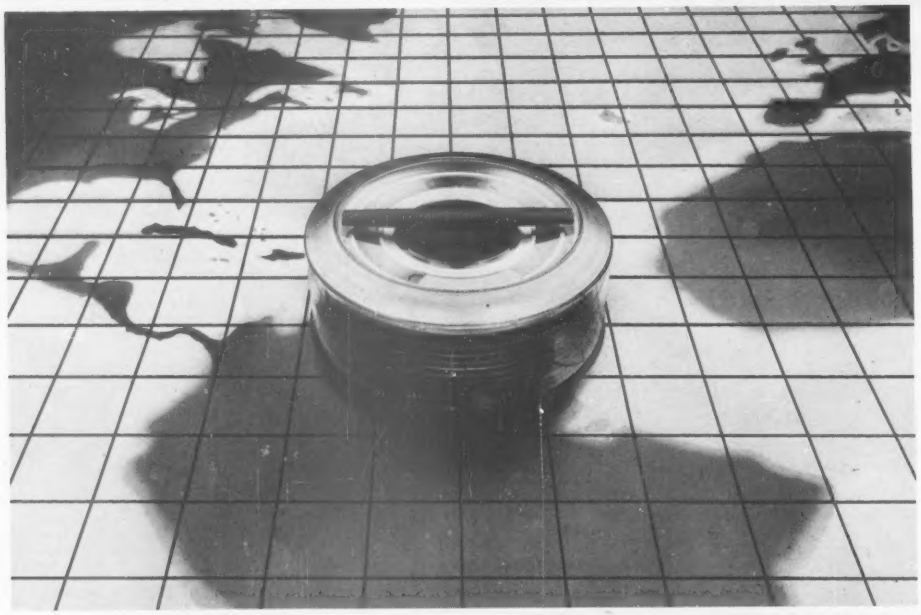
And what will these changes be like? We suspect that, like Japanese firms, the companies in the Western industrialized nations will seek ways to gain much greater employee loyalty and motivation.

Does that mean that U.S. companies, for instance, will have to start offering lifetime employment to employees? The answer probably is "No"; it is not clear that employees even would want that, since it would limit their ability to change jobs or to move to a different part of the country. Employees in the U.S. are accustomed to more job mobility.

What it *does* mean, we think, is that U.S. companies will become even more concerned than they already are about the well-being of their employees. Things must be done to build up a more positive attitude on the part of employees toward their jobs.

Excerpted with permission from EDP Analyzer, *Volume 19, No. 4, April 1981.*

Canning is editor and publisher of EDP Analyzer, *Vista, Calif.* ◇



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By Ira S. Gottfried

UNDERSTANDING THE NEW-BREED DPer

Hardware and software are basically predictable and most of the time they perform according to specifications. Should a piece of equipment break down, we can check a schematic, do a diagnostic test and, if necessary, replace a part.

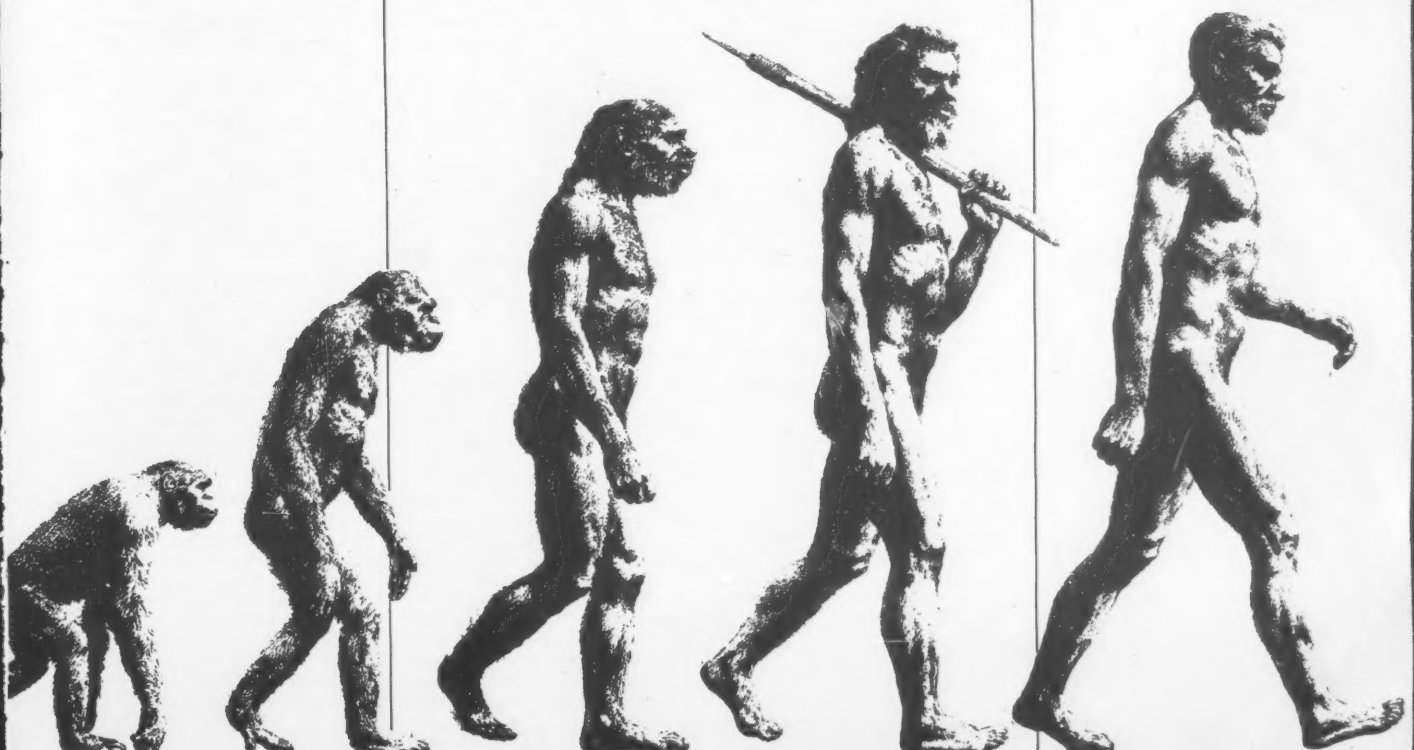
However, people are much more complex to deal with, often difficult to diagnose and even harder to get working well. Each person is configured differently, affected by innumerable variables such as weather, health, relationships with associates and diet.

Through the 1970s, the first priority of the data processing manager was hardware and software; people were important but secondary. This situation is now reversed. Today's effective manager manages human resources first and foremost.

As Abraham Zeleznik wrote in the *Harvard Business Review*, "It takes neither genius nor heroism to be a manager, but rather persistence, tough-mindedness, hard work, intelligence, analytical ability and, perhaps more important — tolerance and good will."

In the highly competitive, volatile environment of the 1980s, *people* are the resource we are most dependent upon for our success. How well we understand our people and their goals dictates how well we turn out our end product of information and the extent to which our company's customers can benefit from what we produce.

As the president of a management consulting firm, I spend much of my professional time counseling senior DP management in many different companies. Throughout the last few years, more and more of our clients who are 50 to 65 years old have expressed discomfort with younger people moving up



Understanding the New-Breed DPer

through the ranks.

There appears to be a growing instability within these companies — a broadening restlessness that is creating a schism between the young DPers ("the new breed") and "the old breed."

By the new breed, I am referring to those born since the end of World War II — age 35 and younger. Are they so different from us, the old breed? Some of us believe so. Consider the young systems analyst who has to leave a meeting early because it is *his* night to babysit. Or the female project manager who comes to work in a dress and leaves in a jogging suit.

They are both members of the new breed of DPers — more independent, more critical and less patient than their bosses were at their age.

The generation gap so touted in the 1960s is still with us. Today's new breed is the same generation, 15 years later. Perhaps the guitar case has been traded for an attache case, the long hair is now shorter, but the individuals that comprised that outspoken college generation are now coming up the management information services (MIS) ladder.

We who are members of the old breed are also 15 years older and perhaps more conservative. The communications gap is still a reality. The burden is on us to attempt to understand who the new breed is and what they want, so we can best motivate them. Today, they are understudies; one day, they will be our successors.

The Old Breed

To better understand the new breed, we must first understand the old. To be more accurate, the old breed should really be referred to as the original breed — the pioneers who entered the DP field while it was still in its infancy.

Background. The old breed are the children of the Depression; the "have-nots." We came through World War II with a strong sense of nation, of teamwork, of group effort required to reach common goals. We were a conservative group — oriented toward security and status.

Education and Skills. Initially, the old breed had little formal training in DP; most learning was done on the job. Degrees were not so important and advanced degrees, if any, were often gained in night school.

We were generalists, wearing many hats, working in many DP departments as we climbed the ladder. It was possible to be acquainted with almost everyone in the field and to know almost all the equipment offered by the few manufacturers.

Through the '50s and early '60s, we felt a growing sense of optimism as we carved out professional careers in DP. We were excited as we tranferred into DP from other areas of our companies, stimulated by being part of the emerging DP world and challenged to get up to speed in this new "world of computers."

Since the old breed were products of a traditional educational system — the three Rs — we had good writing and arithmetic skills. Studies and reports were parts of our jobs.

Relationships with Top Management. Teamwork, work ethic, loyalty — these were the characteristics of the old breed's relationship with the company. We identified with the company — it was "us," not "them." We accepted short-term hardships in return for long-term security and the promise of promotion.

Success meant people skills. We learned to be sensitive to our peers and seniors or we were disciplined or terminated. We accepted the top-down structure of decision making. At the same time, we also frequently saw the humor of it all.

For the first two decades, upper management did not understand what data processing was doing; the terminology and acronyms were a foreign language to them. Thus, we were left pretty much on our own. In addition, there were few external overseers like DP auditors and government examiners. Privacy and security were not yet major issues.

Personal Lifestyles. For the old breed, one-income families were typical and major costs were manageable. Even though we started our families early, we were able to buy homes for a small down payment — even sometimes no down payment.

We had one job and we gave it our all. We worked long hours to "see it work." Overtime was accepted as a way of life, and "the little woman at home" ran everything else.

Having the "right" job with the most "potential" governed where and how we lived. We were corporate nomads, willing to relocate for opportunity, regardless of the family's involvement with school and community.

Our social life was oriented around fellow workers and the company. Our lives were fairly routine. For the few of us who had done any international traveling, most of it had been "compliments of Uncle Sam." We tended to have the traditional moral values of our parents — the family, church and, again, the work ethic.

The New Breed

Let's look at some ways in which the new breed differs from the old.

Background. The new breed of DPers are the postwar "boom babies." They grew up in the age of entitlement; they are the "haves."

Many of them have had comfortable, stable home lives, free from economic uncertainty and insecurity. They take an income for granted and are more willing to take risks and explore alternative lifestyles and drop out from "traditional" society.

They grew up during the '60s and early '70s, in a nation divided over the Vietnam War, shocked by the Kennedy assassinations and disillusioned by Watergate. At the same time, they saw America challenged as a world leader — politically, economically and militarily.

Education and Skills. The new breed is much better educated before they enter the job market — an education generally paid for by us, their parents. They are specialists, normally pursuing only one path up the ladder. Yet their educations, while strong on the technical side, have often been weak in the more basic areas, including rudimentary skills like spelling and grammar. As a result, many firms have had to utilize the skills of technical writers and editors to crutch their young Ph.D's.

Relationship With Top Management. Often called the "me generation" (a phrase probably coined by someone of the old breed), the new breed's loyalty is first to self, then to the field of data processing, *then* to the company. Bigness is bad. Company is seen as "them," not "us."

Rather than being oriented toward the company and its goals, they are more concerned about themselves and their wants. The new breed is willing to express what "turns them on" — or off — even to bosses and customers. Aware of governmentally enforced employee rights, they are less afraid of authority. This makes it difficult to discipline or terminate them — and they know it!

At the same time, they are less passive about the management process than the preceding generation. They demand a role in planning, scheduling and career pathing — now.

As a function of this attitude, they want frequent rewards and promotions. They are quick to change jobs to get more money, especially now that profit sharing is transferable. At any point in time, 21% are actively changing jobs and an additional 45% have resumes circulating. Head hunters add to the unrest, making stability a formidable challenge.

The new breed is not comfortable playing company politics. They are quite aware that there are more jobs than there are qualified DPers. More serious and cerebral than their predecessors, they are less inclined to laugh at themselves.

Personal Lifestyles. For the new breed, a major problem is inflation. It now takes two working mates to reach the level achieved by their predecessors on just one income. For many, new homes are out of reach. Even with both partners saving for the future, a "handyman's special" may be their only option. They're forced to be more financially sophisticated than we had to be — more aware of tax shelters, deductions and the money market.

In today's family, both spouses share domestic responsibility: cooking, dishwashing and child care. With 51% of all women working today, it is no longer just the man who travels on business and attends night classes. A number of the new breed are likely to be moonlighting or subcontracting to earn extra money, and this makes overtime on the primary job difficult, if not impossible.

Another key concern is "value of life" — now, in the present, not in the future. Members of the new breed are concerned about where they live. Is there greenery? Is it near water, mountains, recreational areas? Long driving times to work are not acceptable and the new breed wants to live *and work* in the suburbs.

Relocation, for the new breed, is usually determined by where. If the area is suitable — for example, in the Sun Belt — then moving is a possibility. Either spouse may be the spur for the move — for a better job or to attend graduate school.

Their social life is separate from the company and there is less socializing with other employees. Moreover, the type of socializing has changed. The "after-five drink" has become a fast game of racquetball. After-work activities are considered by many to be equal in importance to business priorities.

In contrast to the insular perspective many of us had in our '20s and early '30s, the new breed is much more aware of the international scene. As the "boob tube" genera

(Continued on Page 123)

Three DP Myths and the FACTS

Technology has a reputation for turning myths into reality. It can also make what was once a reality a myth. You can shatter some of life's more frustrating programming realities using RAMIS II.

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MYTH #1

The 3-year development backlog found at most installations can only be reduced by a massive infusion of new resources.

FACT

A recent survey shows that RAMIS II systems are implemented in less than 1/5 the time it takes using COBOL, FORTRAN, or PL/1 —and the RAMIS II systems typically use no more resources than the average COBOL program to do the same work.

MYTH #2

80% of programming resources are taken up by maintenance work and there's no way to reduce this figure.

FACT

Because RAMIS II commands are precise, concise and clear, users report that maintainance is 50% less with RAMIS II than without—even though RAMIS II systems are modified more frequently because they are easier to update.

MYTH #3

It takes anywhere from 6 months to 3 years to integrate a new software product into an organization.

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DANIEL D. McCRACKEN

Univac I was introduced to the commercial market in 1951, the same year Daniel D. McCracken graduated from college. Business people weren't quite sure what they were going to do with this marvelous invention called a computer. It was large, cumbersome and very expensive; and everyone believed that the only people who could really control these perplexing machines were mathematically-oriented technical types.

That's how things stood when McCracken, with degrees in chemistry and math, joined General Electric in one of the rotational training programs corporations favored for bright, young recruits in the 1950s. Within a year, he was wiring plugboards and he "just never got out of the business."

In 1957, his first book, *Digital Computer Programming*, was also the first textbook available in what was then considered an esoteric area. It covered assembly and machine language for a hypothetical computer. "Over the years, I became convinced that the newcomer to computing should be learning Fortran or Cobol, depending on his area of interest," the consultant says. He responded to this need with no less than seven books on these two languages published between 1961 and 1976.

Times are changing again. Today's end user is no longer intimidated by the magic machines. *A Guide to Nomad for Applications Development*, published by Addison-Wesley in 1981, explains a nonprocedural language targeted towards these new users. In his current work, *Fortran for Engineers and Scientists*, McCracken uses Fortran to teach computer concepts. At the same time, he emphasizes the need to avoid all programming whenever possible.

As a consultant, his client base has included IBM, Intel Corp. and National CSS, Inc. He was vice-president of the Association for Computing Machinery (ACM) from 1976 to 1978 and served as president during the next two years.

Right now, McCracken is busy on two fronts using a personal computer to write his new book and preparing for a year-long stint as an instructor at City College of New York. Maybe that combination of tasks provides a clue to the 51-year-old consultant's success. He isn't afraid to try out new ways of doing things and he maintains his contact with today's students who are tomorrow's technicians.

Flexibility and vision. Not a bad combination for a nationally recognized consultant, writer and teacher. It may be the right mix for the information systems industry during the '80s.

Rita Shoor

Software and programmer productivity are major concerns for today's information processing industry. What does the word productivity mean to you?

I try to avoid defining programmer productivity in very precise terms and I've never seen a definition that seemed to be aiming in the right direction.

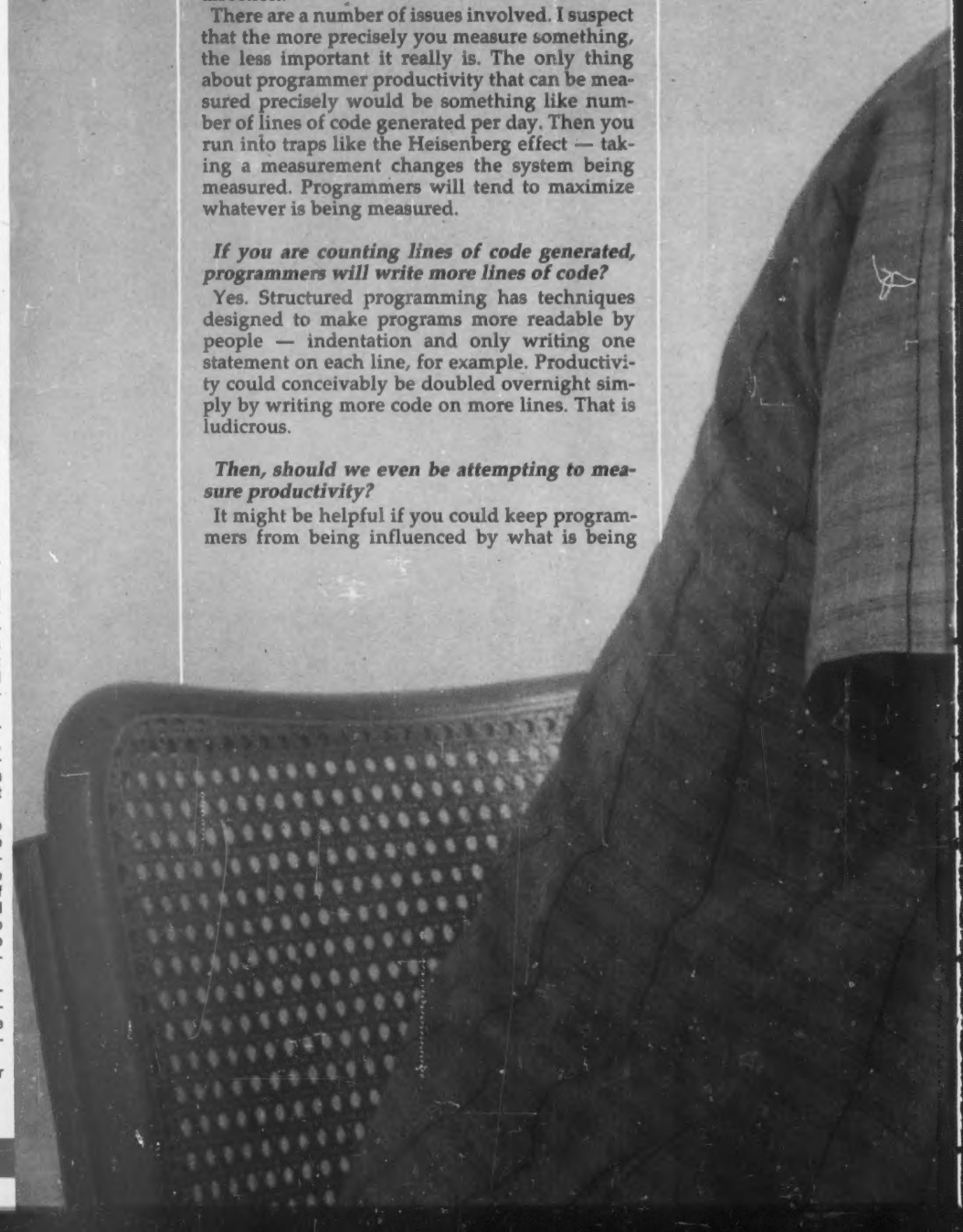
There are a number of issues involved. I suspect that the more precisely you measure something, the less important it really is. The only thing about programmer productivity that can be measured precisely would be something like number of lines of code generated per day. Then you run into traps like the Heisenberg effect — taking a measurement changes the system being measured. Programmers will tend to maximize whatever is being measured.

If you are counting lines of code generated, programmers will write more lines of code?

Yes. Structured programming has techniques designed to make programs more readable by people — indentation and only writing one statement on each line, for example. Productivity could conceivably be doubled overnight simply by writing more code on more lines. That is ludicrous.

Then, should we even be attempting to measure productivity?

It might be helpful if you could keep programmers from being influenced by what is being



"If you think of the problem as programmer productivity, you've prejudged how the work ought to be done..."

"...Instead, we should discuss applications development productivity."

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measured. In any case, it doesn't do any good to increase the productivity of the wrong tool.

What are the right tools?

First, I think we're in the process of switching away from procedural languages. The first instinct of system developers should be to search for alternatives to writing a new program when they must bring up a new application.

Search for available packages; see if someone else has written software you can modify. Maybe it can be done in a nonprocedural language — there are a whole range of alternatives including prototyping and end-user computing.

Prototyping is a tool you've associated with increasing application development productivity. Doesn't it just delay solving performance problems without eliminating them?

The image I have of how this works is that you get a prototype running by using the appropriate technique. *Then* you worry about performance. If your prototype is something that runs in two minutes a month, you have completed the job with the prototype. If performance is completely impossible, a technical expert may be able to improve it by doing something as simple as reversing two steps in the prototyping procedure.

In other cases, you'll have to sit down and reprogram. You may very well produce formal specifications at that point. But you know the specs are right — something you *don't* know with conventional methods. Conventional wisdom is you don't produce a line of code until the user signs the system specs, but that's a defense mechanism. It doesn't guarantee the job will be any better.

The efficiency argument assumes programs written with conventional methods are created by superprogrammers and compares the best conventional methods with the average new product. That isn't fair and doesn't make sense.

Is there a software productivity crisis?

Yes.

What made it happen now?

It's due to a combination of factors. Some might say the information processing industry is a victim of its own success. We've operated well enough to keep people asking for more.

Combine that with the dropping cost of hardware and the fact that it's impossible to get the number of people required to do the additional work with conventional tools and we have a very serious problem .

Two- and three-year application backlogs are becoming the norm and I've even heard of five-year waits in some shops. End users won't risk ridicule by asking for something they need within a week when it takes three months to get it done with conventional software tools and the backlog is already five years.

Will things improve?

Yes . . . at the same rate as we shift to better methods for developing applications.

If you think of the problem as programmer productivity, you've prejudged how the work ought to be done. Instead, we should discuss applications development productivity.

But I don't foresee backlogs dropping to six months in the near future, regardless of the methods we use.

Is this a never-ending cycle?

It's sort of a rolling crisis. As one type of problem is solved, we move to more difficult ones.

Unless the need for computing becomes saturated and end users stop requesting application solutions, there may well be a backlog problem in the distant future. And I hardly see computer saturation taking place within the next decade.

Why are hardware costs going down and software costs spiraling upward?

The two items are obviously interrelated. There has been a tremendous amount of innovation in such areas as chip fabrication and computer architecture. Hardware vendors are getting economies of scale. Dropping hardware costs increase the demand for computing. But the number of people available to meet that demand is relatively stable. In that situation, free enterprise inevitably drives prices up. This is compounded by the fact that people are going into industry instead of getting Ph.D.s and teaching new generations of programmers.

The supply of future systems programmers — the people who write the software tools — are affected first

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Interview With McCracken

by the brain drain from the universities. The shortage of systems programmers is critical since the software tools they produce might get us out of our current state of crisis. Conventional training for a systems programmer is a degree in computer science, but the demand for these people is so great that faculty and future faculty is being hired away from universities.

Many techniques — design, analysis, programming walkthroughs — have had the adjective "structured" applied to them.

Yes, to the point where the term is just about useless.

Do these techniques have a positive effect on productivity?

I'm sure they do when used intelligently. As far as structured programming is concerned, I'm satisfied it boils down to using some commonsense techniques like indentation, avoiding Procedure Division literals and limiting logic structures to a small set. The goal is simply to write programs that are understandable by people. In the case of Cobol, these techniques can be explained in a few hours.

Someone like Djikstra may say something like "I think on average it would be better to write programs in a certain way" and that turns out to mean that you don't write very many GOTOs. Someone with less breadth of vision may translate that to mean "don't ever write GOTOs."

The core of structured design is also drawn from generalizations based on a lot of experience. It was primarily Larry Constantine, as I understand it, who came up with a way of determining criteria for program modularization in terms of minimizing the interactions and limiting them to data flow rather than control flows. Stated that way, it's a simple, elegant and very brilliant concept that's been nicely popularized by people like Edward Yourdon and Glenford Myers.

But if it is applied by people who don't quite understand why they are doing things a certain way, they tend to get bogged down in the mechanics of trying to apply cookbook rules rigidly.

Assuming these techniques are used, how can top management be persuaded to wait for the payback?

I don't buy the assumption that making application development more productive necessarily requires more effort at the front end. I'm not sure that's true of the techniques I favor.

Techniques like prototyping actually require less up-front effort. It allows the designer to bypass traditional requirements definition, complete specs and so forth. Conventional methods have been tried and they don't work.

The designer can get something running very quickly with a nonprocedural tool like Nomad or Focus that can be used to find out what the user really wants. "I can't tell you what I want, but I'll know it when I see it" is the slogan of the end user.

A small prototype helps him while clarifying things for the designer. That never is true of design specifications. The main purpose of specs is to have documentation with which to hang the user when the project is late.

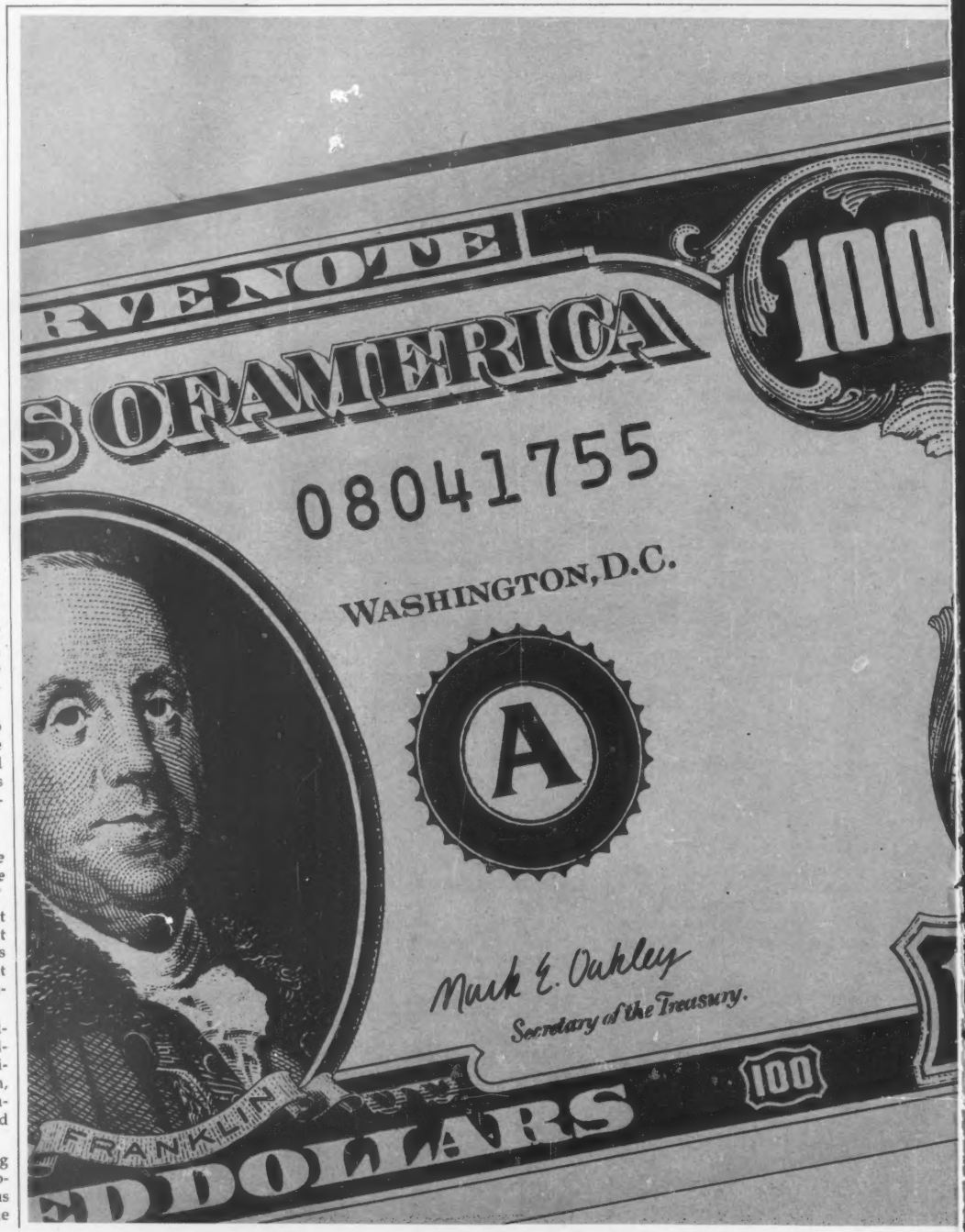
If the project is huge and complex, you may have to write specs — *after* prototyping — and the programs may then have to be written in a procedural language. In other cases, the end user may be able to go with the prototype that was developed in a day or two.

Increased end-user involvement is an emerging trend in systems development. Why?

First, there aren't enough systems specialists to get the work done. Another reason is that if we can supply tools for the end user to handle an application on his own, we avoid communication problems between the computer specialist and the end user.

There are many installations where end users are getting a lot of work done in less time than it would take to explain what they want to a programmer. No information systems director would consider having the user design a big data base himself. But, after the data base is implemented, technicians can create subfiles that the user can certainly access on a read-only basis.

My book in manuscript, *Fortran for Engineers and Scientists*, emphasizes the move toward end-user computing. But I'm convinced that as time goes on, it will be much less common for noncomputer professionals to actually write programs. If they have a



"It would be nice to hope the backlog can be reduced . . . Right now, we're not holding our own, much less catching up."

problem that doesn't fit some existing package, it's probably too tough for them to write a program to solve it. At that point, they must rely on a computer expert and determine with him the reasonableness of the request.

And I don't know how to teach a person — beyond the game level — about a computer's capabilities and limitations without having them learn some programming language.

Are the end users programming in any traditional sense?

No. They usually access the data with some sort of a query language. There is room for a great deal of research and experimentation in this area. There are a lot of query languages and they aren't all alike. Some type of standardization is becoming desirable. In addition, some of these products are highly nonprocedural in terms of generating reports, but revert to a procedural language for data maintenance.

You have said that "more DP managers are welcoming heavy end-user involvement instead of feeling threatened by it." Why this change?

Simple demonstrations of end-user computing capabilities . . . Managers are beginning to realize it's a way of providing service to the end user that is otherwise impossible.

Some DP executives are intimidated by increasing end-user involvement. They fear losing budgetary control — the empire-builders' syndrome — and, more fundamentally, they worry about losing control over standards.

They argue the user could accidentally destory data bases so that after a few years, the new chaos will be worse than the present one. In reality, that does not seem to be happening at firms committed to end-user computing.

The Bank of America in San Francisco is one example. Two large mainframes are running Nomad applications that have been generated by end users in various application areas. These groups have access to a technical support staff of about six people who teach end-user-oriented courses and provide any necessary hand holding. This combination of DP support and end-user application development makes everyone happy.

Will end-user involvement shrink application backlogs?

I'm not sure that will happen. End-user computing may simply expand the demand. One result could be more computer usage with more useful results, but with little or no effect on the amount of work so complex that it must be done by DP professionals. It would be nice to hope the backlog can be reduced, though. Right now, we're not even holding our own, much less catching up.

Do end users see this increasing ability to directly utilize computer power as job enrichment or "just some more work"?

I don't really know. I suspect a combination of both attitudes. There may be a certain amount of exasperation because they *have* to do things for themselves. But there really isn't much choice when the end user can in 15 or 20 minutes solve application problems that would take two months to program in Cobol.

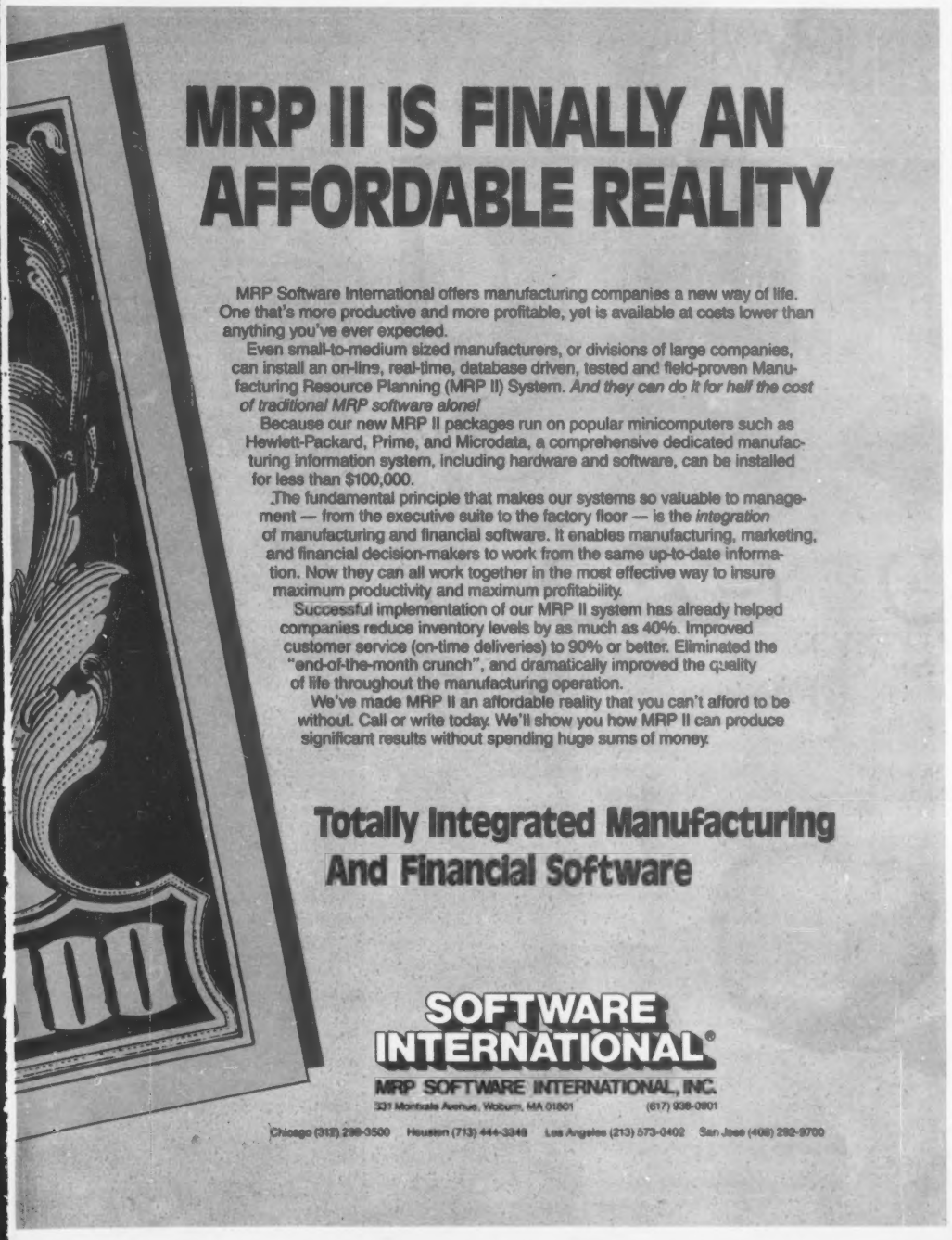
Relational data base management systems [DBMS] are said to be end-user-oriented, but experts differ on what makes a system relational. Are there any truly relational DBMS available in today's commercial market?

I've read some of the debates over what constitutes a "real" relational data base and I have trouble understanding what some of the experts are saying. Based on some pronouncements, there may not be *any* relational DBMS.

On the other hand, there are a number of systems that definitely have a relational model. IBM's Ted Codd, who invented the concept, seems to think some relational systems exist and I hear C.J. Date, who wrote a book that serves as a standard on the subject, will describe Nomad as a relational DBMS in his next edition.

As far as I'm concerned, the essence of a relational DBMS is that the relationships between the entities in the data base don't have to be defined in advance. They can be established when the data base is initially set up or *at a later time* with no penalty to pay for the second choice.

I think that Nomad, Focus and Ramis can be described as relational along with Query by Example [QBE] — although QBE is a different type of product. SQL isn't on the market yet, but it will certainly be considered relational. I get the impression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quite a bit of unnecessary haggling is taking place over the matter of a precise definition. However, I don't claim to be an expert on data base definition.

Are relational data base systems preferable to hierarchical or networking models for increasing information systems productivity?

As a broad generalization, that is probably true. Naturally, anyone can construct examples where a hierarchical organization seems to be the obvious answer. On the other hand, I'd like to talk to people five years after system implementation and see what it costs to maintain the system. Reorganizing a data base after it's been in operation for a few years — changing field lengths and adding new relationships that couldn't possibly have been anticipated — can make for the agonies of the damned. A lot depends on the details of the implementation.

Relational types of software are being used in ways that developers didn't anticipate. So, the products weren't optimized for those kinds of usage. There is a great deal of development still to come.

Will relational software products eventually replace older DBMS like IMS?

No. Some of the older systems are so deeply entrenched there is no way that could happen. In addition, no one claims such packages are ideal for *all* applications. There are certain kinds of extremely high-volume, transaction-driven applications requiring vast numbers of on-line terminals with huge data bases where a product like IMS is probably the right choice.

Relational products would be additions to, rather than replacements for, large DBMS. This happens in a lot of fields. New ideas don't really push old ones out. They just take over in new areas.

On-line and real-time are the two big terms in systems development today. Are we ringing the death knell for traditional batch systems?

Batch systems are certainly not where the action is. What seems to happen is the newer methods or applications generate the excitement and have the biggest growth. That doesn't mean more conventional systems are dying. They're just not growing as fast and aren't perceived as exciting by the technicians.

Employers are sometimes reduced to promising that new hires will work with on-line systems. That could affect the kinds of applications that get implemented. If the real need is to completely update an existing batch system, but people refuse to work on the project, it's difficult to get the job done.

We haven't reached the point where programmers work only on what pleases them yet, but, to a remarkable extent, they're in the driver's seat.

End-user computing, prototyping nonprocedural approaches and changing DP management attitudes are all with us now. Where will these trends be in 20 years?

I don't make 20-year predictions. I can't see that far ahead.

How about by 1990?

Pulling these trends together reminds me of the telephone operator analogy. During the '20s, someone predicted that, given the rate of growth of the telephone company, everyone in the world would be a telephone operator within 50 years. *That's exactly what happened.* We *are* all operators, in the sense that 90% of what was done by an operator at that time is now being done by the telephone company customer.

It's instructive to ponder this and wonder if we have similar things to look forward to in business. The number of telephone operators did not decrease and no one has to worry about all of the programmers being thrown out of work. The total amount of telephone usage went up by a huge factor. The switch to end-user involvement in that sense made telephone service a great deal more valuable to users.

Without pushing the details of the analogy, the trend is to develop more tools that have the effect of putting the power of the computer closer and closer to more people. This expands the range of service available, the amount of service demanded and the interesting work to be done in providing it.

If someone comes along with an absolutely new and different way of doing things, or if there are catastrophes with strong negative factors like something really vicious in fraud or if the public mood turns against technology, the entire ballgame changes. I can imagine those

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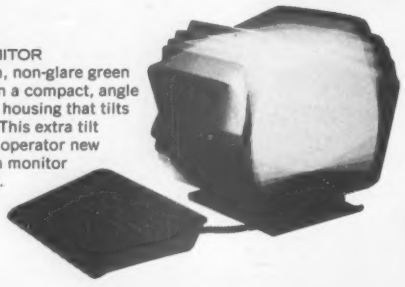

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Interview With McCracken

things happening, but I'm not predicting them.

Let's talk about Cobol. It's still the most-used high-level programming language in commercial installations.

Absolutely.

Where does it fit into the DP shop of the future?

It will be used indefinitely. That's one prediction I *will* make. Cobol will still be around in 10 years — maybe even in 50 years in one form or another.

One reason for that is inertia. Given the tens or maybe even hundreds of billions of dollars already invested in Cobol programs, even if everyone agreed language XYZ is incredibly better, you couldn't rewrite everything instantly.

There are always going to be some applications where Cobol or something very much like it will be the appropriate way to get the job done. I'm not saying these new techniques will take over everything. So no Cobol programmer should have the slightest fear of being out of work.

The slow trend will be that growth in the use of Cobol will be slower than growth in such areas as applications packages, data base tools, text formatters and graphics.

Are languages like PL/I, Pascal, Basic or Ada realistic alternatives to Cobol?

The answer is not the same for all of those.

When PL/I first came out, there was something of a movement to switch from Cobol to PL/I. There's almost none of that now and I don't think that will change. People using PL/I will stick with it for much the same reason . . . inertia. That's not perjorative, it's simply a fact of life. It's extremely difficult to reprogram in another language, and the transition problem is huge. You can't shut things down while you switch.

There is also a retraining problem. So, for a combination of good and bad reasons, I don't see people switching languages very much in standard shops.

The interesting versions of Basic are all vast extensions of a standard and they are all incompatible with each other. Even at that, it's a pretty low-level language for business use unless it gets extended so far as to be a subset of Cobol.

I have heard Pascal promoted for business use by law-abiding citizens who seem to know what they're doing. But I don't imagine they'll convince very many people. Pascal is a marvelous invention; Niklaus Wirth and his colleagues deserve a lot of credit. But I doubt if it's really appropriate for business use. It has to be extended pretty seriously. An entire I/O package would have to be added. Once you do that, you have a big standards problem.

I'm not a big admirer of Ada at this point.

Why not?

Partly because there are no compilers for the programs right now. Ada developers are attempting to standardize the language before the compilers are written. The first production-quality compilers aren't even promised until '83 and that is apparently a deliberate choice. People whom I respect very much say they don't know of a better way to develop a language. The effort that went into arriving at the point of beginning standardization was intense and required a great deal of thought from a lot of people. However, we've never before adopted a

(Continued on Page 124)

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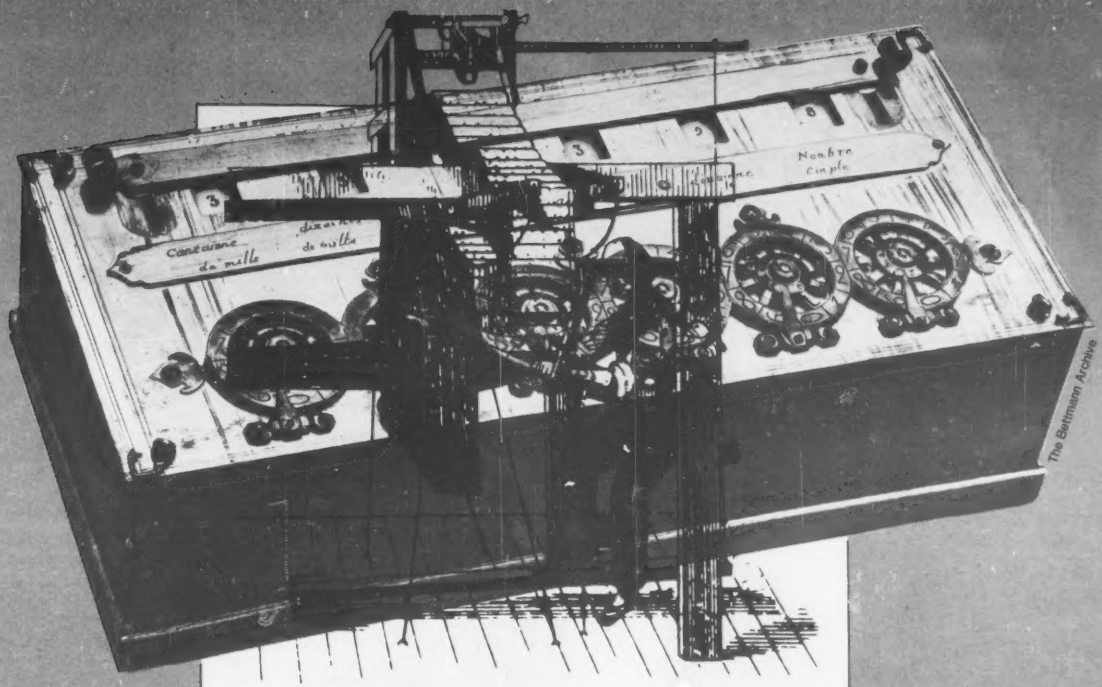
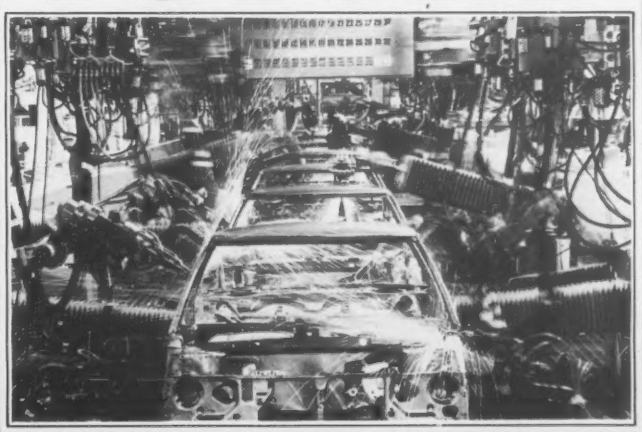


The word "robot" was given to us in 1921 by a playwright named Karel Capek, whose play *RUR* used the term to describe a mechanical worker. In the final scene of *RUR*, a robotic Adam and Eve walk off into the sunset, having destroyed the last human being on earth. Perhaps because of their unhappy fate the word has tended to conjure up a vision of menacing manlike machines in the minds of many. One notable recent exception: the friendly robot characters, C-3PO and R2-D2, in the *Star Wars* series.

As we enter a period in which Capek's original concept of the mechanical worker might be fulfilled, we should take care not to misunderstand its technology, but to appreciate management options resulting from present-day robotic systems. A good starting point is the definition generally accepted

By Thomas E. Lipinski and Charles S. Skinner

IS THERE A ROBOT IN YOUR FUTURE?



Is There a Robot in Your Future?

by the industrial robot industry: "An industrial robot is a programmable multifunctional device designed to both manipulate and transport material, parts, tools or specialized manufacturing implements through variable programmed paths for the performance of specific manufacturing tasks."

Basically, industrial robots come in three general classifications: pick-and-place, general purpose and special purpose. In addition, their flexibility is defined in terms of "axes" or degrees of freedom, with the speed of movement typically inversely related to carrying capacity. Virtually any robotic system will also include subsystems with varying degrees of sophistication: memory, control, actuation, sensing and structure.

Early Applications

Although Capek coined the term, the modern industrial robot originated with J.F. Engelberger, who began development of an industrial robot along current lines in the early 1950s and demonstrated a model of his robot to General Motors Corp. in 1961. For the next 15 years, Engelberger's company almost single-handedly led the development and introduction of the industrial robot in the U.S., established the confidence of successful users and, incidentally, absorbed the burden of badly chosen applications.

Early industrial robots successfully unloaded machines, attended machine tool centers and manipulated paint sprayers. In addition, some air-powered, air logic-controlled pick-and-place transfer devices were branded as robots by their manufacturers during this same period. The first large, high-visibility, successful application of robots occurred at the General Motors Lordstown plant, where some 27 were used to spot-weld bodies for the Vega. This was studied by a number of potential users and marketers and is considered a major milestone in the commercialization of robotics.

Today, some 2,000 U.S. robots are sold annually, representing a $90 million market, and most large manufacturing-based companies have some sort of robotics program in progress. Significantly, the U.S. leads the world in the sophisticated application of general-purpose robots, although Japan — with a plethora of pick-and-place devices — is sometimes credited with employing nearly one-half of the worldwide robot population. In all, Japan currently operates about 10,000 robots, compared with 3,000 in the U.S. and about the same number in Western Europe.

Applying Robotic Technology

The decision to apply robotic technology to a manufacturing operation is usually a push-through process. That is to say, senior management or the technology group decides if the time has come for the facility to become robotized. A search is then made for appropriate applications, and these are evaluated to determine those best suited to modernization through robot technology.

The factors that drive that decision generally are labor-related, with the economic justification of a robot system arrived at in the same manner as the budgeting for any piece of capital equipment. The alternatives are usually a single worker or a piece of dedicated capital with the implementation cost being traded with that of direct labor. For the most part, robots and people are exchanged on about a

Characteristic	Class	Description
Type	Pick-and-Place	Simplest; used primarily to transfer components; may perform one or two tasks; usually lowest cost; often interchangeable with dedicated automation.
	General Purpose	Largest class; programmed by teaching or as NC machine tool; larger, smoother, cost two to 10 times more, programmable for far more intricate operations than pick-and-place; some can execute preprogrammed routines per exterior sensors.
	Special Purpose	Often general-purpose with special features for a specific task; spray paint robot must be well sealed, have sufficient memory, and be explosionproof; arc weld robots may have weave patterns, incorporate wire feed rates, must operate smoothly and are more expensive than general-purpose.
Carrying Capacity		The trade-off with load capacity is size and speed. 1- to 2-lb loads can sequence up to 100 cycle/minute; hundreds of pounds are considerably slower and require a much larger structure.
Axes (or degrees of freedom)	3-axis 4-axis 5-axis 6-axis	A robot usually has 3 of the axes as part of the body, and the balance as part of the wrist. With a seventh movement axis, the robot can roll across the floor along a preprogrammed path.

Typical Robot Types and Characteristics

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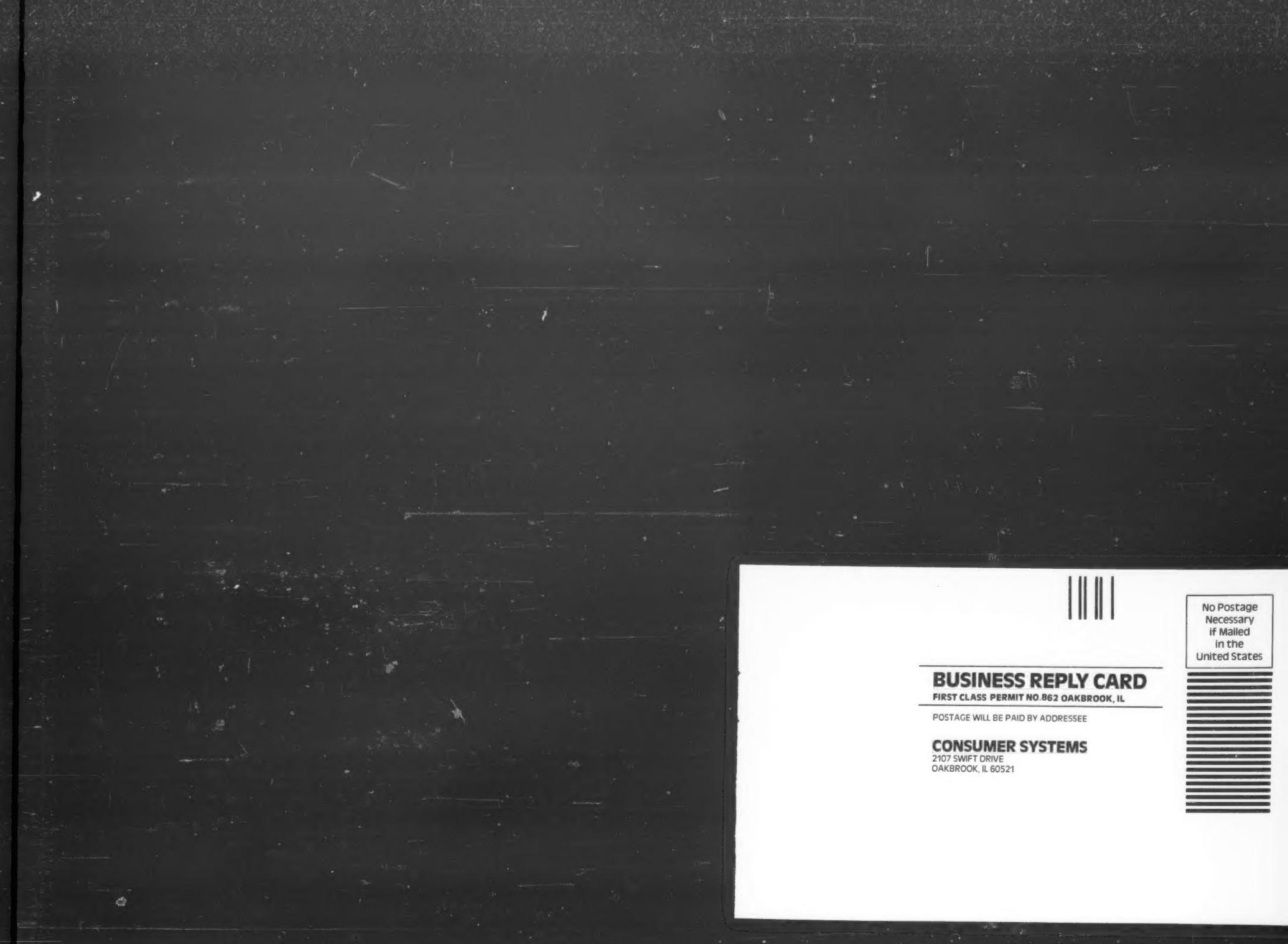

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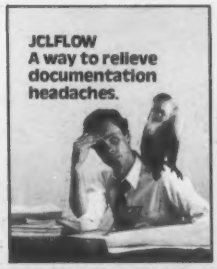

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Is There a Robot in Your Future?

one-for-one basis, with capital dollars being exchanged for direct labor dollars.

Based upon an array of current robotic system applications — and given that a man-size, general-purpose robot will have a base cost of $20,000 to $60,000 — then in terms of the purchase price:

- The annual labor cost of a single worker, including fringes, will be approximately one-half the cost of a basic robot, with the anticipated life of a robot system typically being seven to eight years.
- The installation, tooling and start-up costs will generally be approximately one-half the cost of the robot.
- Annual maintenance costs will run about 5% for one shift and 7½% for two-shift operations.
- Programming and routine engineering services will generally cost between 5% and 10% of the cost of the robot.

The expected return is largely a function of the number of shifts that the robot system works or the speed at which the robot works relative to the human worker(s) it replaces. A robot replacing one man directly can pay back its costs within five years. One replacing a single person on a three-shift basis will pay back in one and a half years or less.

Lower material usage, improvements in product quality, a better worker quality of life and other intangible benefits are additional justification for the use of robots. The extent of their impact will depend on their particular application.

Intelligent Automation Systems

Robots are intelligent automation systems that can be developed to perform work tasks in a manlike manner. They possess memory and self-control; trainability and reliability; ability to provide forces, displacements and speeds; and the ability to respond to environmental conditions. The popular school of thought positions the robot as a universal transfer device, suited primarily for pick-and-place activities, but if the manager considers the concept of an "intelligent" automation system, then the opportunities for application expand.

The concept of the intelligent automation system is an important one. When managers confine their concept of robotics entirely to the general-purpose universal transfer device they seriously limit the areas in which robotic systems may be applied and their inherent advantages realized. Intelligent automation can increase productivity in many more areas than those allowed by the simple robot transfer system. Once these types of systems are included in the same frame of reference as numerically controlled machine tools and automatic control systems, managers will more easily recognize opportunities for applying this revolutionary and exciting concept.

Adaptive Control

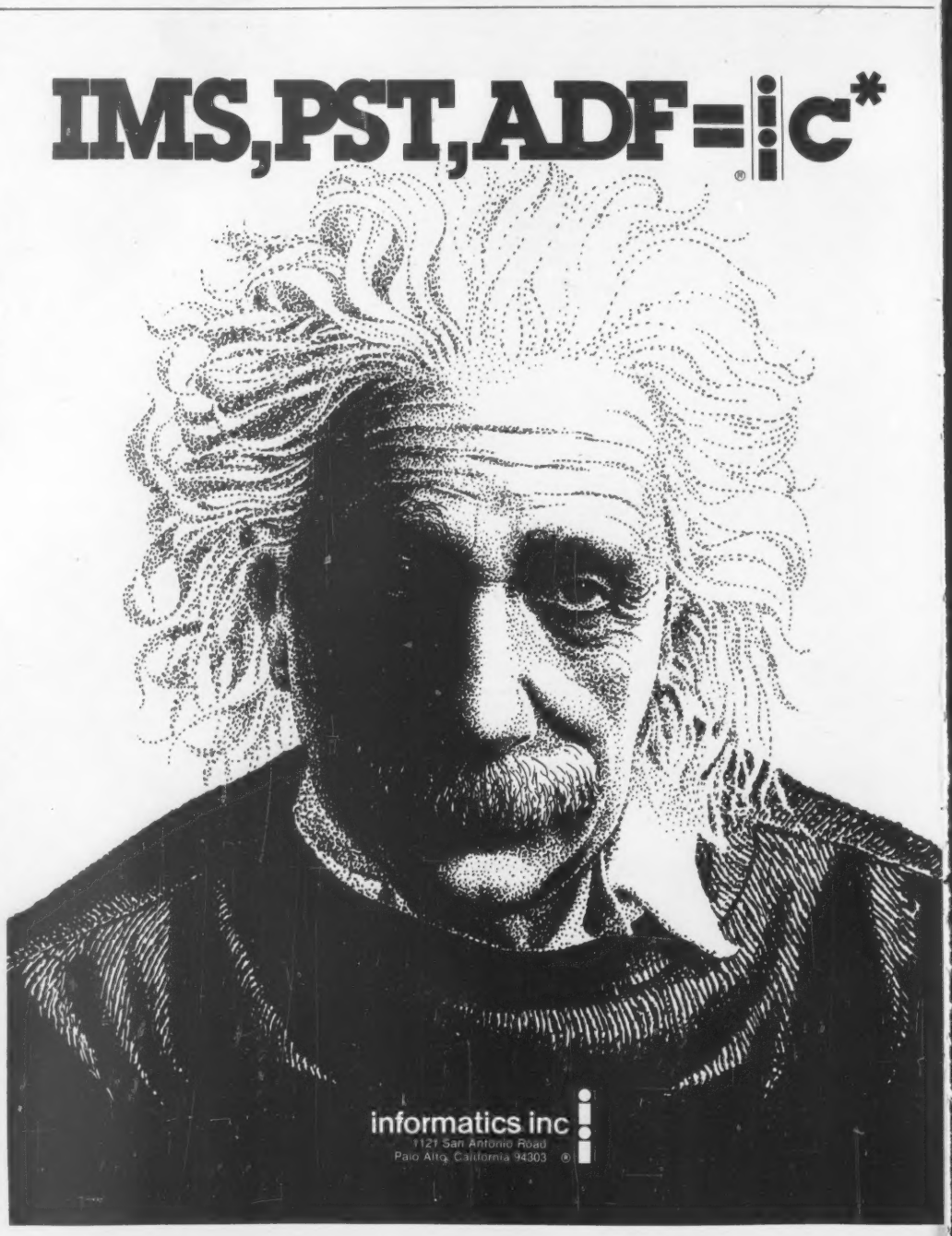
Adaptive control, the technique of modifying the robot's activity with data collected from a sensor, has been under development in the U.S. and abroad for a number of years. It is a key factor in increasing robot capabilities to include "humanlike" sensitivity to touch, sight, temperature and sound.

This technique has been applied recently to numerical control machine tool technology as a method for detecting both dull cutting tools or changes in the characteristics of the material being machined. The forces are translated into information used either to modify the path of the tool or to signal the need for attention. The benefit of such a feature must be traded off with its cost and perhaps slower operation, because of the data processing time required.

Provided sensing technology is available, adaptive control can respond to virtually any environmental condition. The limiting factor then becomes the number of and rate at which programs can be developed, stored and executed in response to any preprogrammed and sensed set of environmental conditions. As the number and rate increase with technological developments, robots will become more humanlike.

When manufacturers are finally convinced that there is a robot in their future or that they can profitably apply intelligent automation techniques, they should start with a simple and safe application. The application may not pay out in as short a period of time as might be expected, but it is important that this first attempt be successful from implementation, psychological and economic standpoints.

The highest probability of success rests with those applications that most readily take advantage of the strengths of the robotic system and



"A machine that simply stacks cartons onto a pallet may not be the most cost-effective application."

stay clear of its weaknesses. For example, proven applications will become cost-effective long before a specialized assembly operation *stops* costing money. A machine that simply stacks cartons onto a pallet may not be the most cost-effective application. It will, however, provide the opportunity to gain familiarity with the system and will not be taxed to the limit of its capabilities. It is hard to ease into the game without paying one's dues.

The burden of training robotics specialists and maintenance of the robots usually cannot be carried by a single unit. Instead, the acquisition of one robot will require a considerable expenditure in training and familiarization by the maintenance, manufacturing and engineering functions of an organization.

Usually, installation of fewer than three robots will not be economical unless a facility has an established level of experience in numerical control (NC) equipment and special machinery. This should be considered by a firm contemplating its initial venture into the world of intelligent automation, and even more important, by the firm that is postponing the venture.

In some manufacturing facilities there may not be an application for the traditional robot, but there might be applications for specialized machinery. Such organizations might consider, as a first exposure to intelligent automation, the inclusion of a programmable feature into their special or standard equipment.

When planning the first intelligent automation venture, a manager should also consider maintenance, safety and space requirements. The existing maintenance force that does not include experience and/or skills in solid-state electronic technology or servohydraulics will need upgrading. Heavy reliance on technical staff to supply aid may be acceptable over the short term, but will be wastefully expensive if permitted to continue for more than a few months.

Safety and space are interlocking considerations. Isaac Asimov, the science writer, has stated that there are three rules of robotics that may be reduced to three standing orders for robots.

- Never hurt a human.
- Obey human direction unless it conflicts with Order No. 1.
- Never hurt self unless it conflicts with Orders 1 and 2.

Many robots have a substantial operational envelope making them capable of reaching well beyond their assigned work area. This necessitates that some safety measures be taken in the event that someone attempts to enter the envelope. Frequently, the robot's area is fenced off or is equipped with a pressure-sensitive mat or some other sensor which will disarm the robot should a person enter. This problem becomes less intense when a greater number of robots is applied, since they will typically share a given work area that has been closed off. However, the amount of space required by a single robot operating within a factory is substantial, often requiring that an area 20 feet in diameter be marked inaccessible for humans during robotic operation.

Application of intelligent automation will become easier as we expand our related body of knowledge and experience. Experimentation in the laboratory has already demonstrated the ability of robot systems to select components from bins and to position them in machine tools. The speed of this process is slow now, but it will increase when the data processing capability required can economically be included as part of the system.

Robot Communications

Robots, increasingly, will communicate with each other. In this environment, information about a particular component might be transferred down an intelligent automated assembly line, allowing corrective action to take place or to have subsequent operations modified or curtailed depending upon the need.

Robot welding will be enhanced with the addition of adaptive controls and vision that will sense correctness of fit and will execute the proper welding technique to fill larger gaps or to avoid extensive buildup at closely fitting joints. These techniques are under development at a number of centers around the country and will be incorporated into intelligent automation and robot systems in the future.

Robot inspectors will also keep records and provide data to the manager via a distributed intelligence system in the manufacturing facility. This will enhance the manufacturer's ability to monitor the quality of the components, capacity utilization and

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Is There a Robot in Your Future?

productivity throughout the manufacturing process on a real-time basis.

As data handling capability continues to grow, it will be possible to add fault correction techniques to a robotic system. Such a system is being pursued by a Japanese manufacturer, who at the end of the work shift leaves the robot system operating. The system continues to function until it encounters a condition it cannot rectify and at that point it shuts itself down and awaits the repair or correction provided by the first returning shift of employees.

Finally — and perhaps most exciting — as the cost of data processing components and servo-mechanisms continues to be reduced, we will see roboticlike intelligence extended to a number of industrial devices.

Some of the potential results:

- The smart belt conveyor capable of adjusting its speed or direction to match the processes on either end.
- The smart pass-through furnace that will optimize the heating and cooling cycle depending upon the size of the part or the mass load on the system.
- The intelligent coining press that will adjust its top punch penetration to compensate for a variation of stock thickness.
- The smart forklift that will transport work in process from storage areas to work centers.
- The intelligent transfer line made up of a series of NC machines with tool changes and inspection devices that will adjust tooling based on the results of the inspection operation immediately following.
- The intelligent cutoff saw that will process a day's worth of stock cut-to-length and delivered to the welding operation.

Impact

While the explosion in intelligent systems has been predicted for a number of years, a series of recent events guarantees that a revolution in intelligent processes is about to take place throughout the manufacturing community. The current integrated computer-aided manufacturing and the manufacturing technology modernization programs sponsored by the U.S. Air Force are just two examples of financial commitment that contribute to a climate suitable for the development of the techniques and the equipment necessary for this revolution. The dramatic improvements in computer technology as well as the exponential decrease in the cost of data processing hardware make possible the necessary intelligence at economically justifiable levels.

Lagging productivity growth — combined with across-the-board increases in basic costs of doing business and a changing work ethic — has imposed impressive demands on management to improve manufacturing systems.

We contend that an answer at least partially lies in the technology we have discussed in these pages — technology applied by astute management and implemented by an educated and adaptable work force that will ultimately come to see the benefits of technological innovation in terms of improved standards of living for all concerned.

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By Louis H. Mertes

THE PROFESSIONAL ENVIRONMENT

IN THE 21st CENTURY

As we plan for the future, we look for the things just emerging that appear to have perversity. I say "perversity" because emerging problems that are serious in nature will most certainly follow us to the 21st century. But, then, so will our new technologies. Improved, sophisticated and adapted to new uses, they will become a resource that will help us combat the problems of tomorrow.

In attempting to see what the professional environment in the 21st century will look like, this paper focuses on the many and varied tiers of professional specialties that comprise the management of the large corporation with many local and international offices. Our interest is centered on accountants, planners, economists, financiers and salesman, as well as the marketing and operations management teams. These people will be performing much the same functions in the 21st century that they do now — functions that by their very nature require a high degree of communication, negotiation, moni-

toring, research and documentation. The need for information throughout this group is great, as corporate strategies and objectives are formulated, executed and evaluated. Disseminating the information requires crisscrossing the whole corporate hierarchy.

Closer Look

What then will be the biggest change affecting the corporate professional as we approach the 21st century?

In my opinion, it will not be what these people do, but how they do it. Let us take a closer look at some of the people in our typical corporation, starting with a midwestern sales coordinator.

As his primary office, the coordinator uses the study in his suburban home. From here, he directs all the activity in the 10 small sales offices dispersed throughout the Midwest in or near major industrial centers. He uses his telephone to dictate letters, memorandums and reports through the corporate centralized word processing center. The center relays his draft copies back through his electronic mail terminal at home, to be edited and disbursed throughout the day.

Through electronic mail, the coordinator receives specifications for new contracts developed by the salesmen in the regional offices. He comments, approves or rejects them through the mail system. He frequently works on his specifications at odd hours because he prefers to reserve the primary "office hours" for important customers and personal contacts in his community, in which he is very active.

The controller, located in the head office, is also a heavy user of electronic mail. He is responsible for the cash management function. Financial information from each office is instantly available to him, and he disseminates it to his staff for further analysis.

The controller also receives account balance and investment data over the mail terminal from his banks and investment advisory services. Up-to-the-minute bond quotes and rate changes are called into his telephone answering device. This permits him to accumulate verbal data while attending to other matters.

Key maturity or paydown dates are stored in the mail data base with a follow-up date; the controller thus will be reminded by mail of action needed on the day that it is required. Financial information, continually fed into several data bases and called up by the controller at will, is automatically displayed on graphs and comparison charts.

Operations Manager

The operations manager is responsible for a production unit in a small town near the city in which the head office is located. His unit was moved about five years prior to take advantage of a highly attractive labor market and lower operating costs.

Although the operations manager uses the electronic mail and dictation features, he is more heavily dependent on his phone answering device than on any other mechanism. He likes to move constantly within the plant, to inspect problem areas and to consult with his management staff, and he carries a small device to pick up his messages every 30 to 60 minutes.

What used to be a small "beeper" is now a miniature recording and storage device; thus it is possible for him to relay and play back an entire message.

Those familiar with the recent explosion in microelectronic games and devices and the popularity of large-screen TV know that none of what has been described is far-fetched. All these devices are available in some form today for office automation. Telephone answering devices, equipment for dictation and word processing equipment, for example, have been available and economically justifiable for the past 10 years.

How to Overcome Resistance

What, then, will be the catalyst to force industry to embrace the technology it has thus far either ignored or underutilized?

Rapidly escalating costs at rates higher than the projected rise in revenue form the basic factor forcing businesses to address the issue of productivity.

Because of the heavy emphasis on automation at the clerical level, which occurred during the last decade, significant strides or new opportunities probably will not occur again at this level.

The professional level, however, has been virtually untouched. More than 50% of today's work force is

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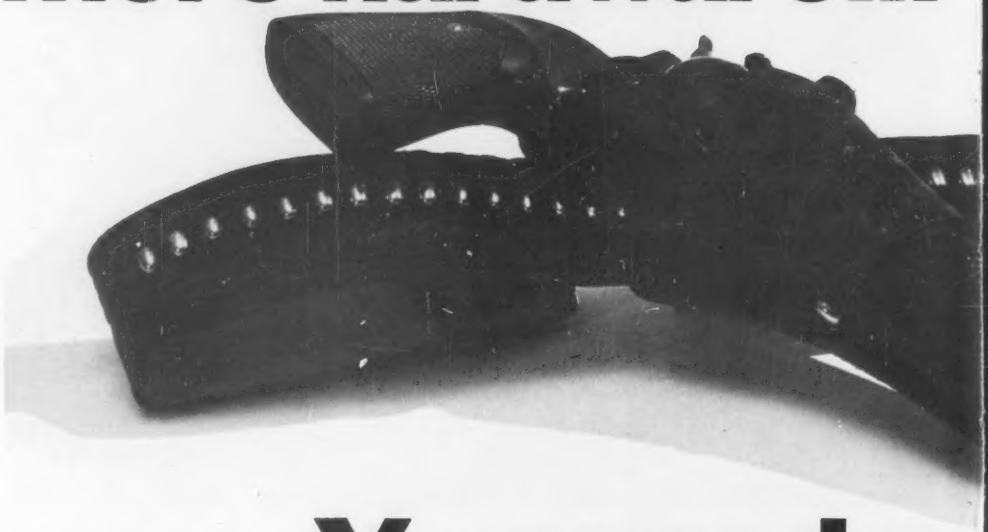

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"Deep emotional issues are stirred up when the issue of our own productivity is raised."

made up of professionals. The professional level happens to be affected particularly by the high cost of energy because it is the most mobile corporate segment. Professionals usually commute farther to get to the office, travel to visit customers and manage interoffice affairs or several offices. They are also heavily involved in community-, industry- or government-related affairs outside the office.

The costs generated by the professional, though necessary to support his continued contribution to the growth of the corporation, will become more visible — and more painful — as inflation and energy costs continue to soar. It is therefore safe to forecast that industry will ultimately push technology on the professional level in the same way it eagerly adapted automation on the clerical level.

Obstacles to Technology

What are the obstacles that confront us and why is there not a greater acceptance of the technology today? Two factors play a prominent part in the problem.

The first involves the professional himself, particularly the professional who is well-versed in his field and comfortable with his area of responsibility for other people. We professionals are focused analytically on devising practices and policies to make others more efficient; we are outward-directed and immersed in the issue of our staff's productivity.

However, deep emotional issues are stirred up when the issue of our own productivity is raised. All the clear and precise logic we eagerly apply in automating the jobs and processes of the clerical work force becomes vague and confusing when turned inward on one's own habits and those realms with which we are familiar and comfortable.

Some executives may also be reluctant to give up what they perceive to be the accoutrements of their success — a secretary, a large travel budget and several offices. Electronic wizardry does not yet convey the subtle messages associated with these older trappings of executive power. The executive realm of the corporation is steeped in tradition and status.

The second cause of resistance arises because most professional people view their jobs as cognitive in nature; they describe their activities in terms of planning, forecasting, negotiating, researching, creating and so forth.

The motor tasks associated with the cognitive tasks — handling the telephone, walking to meetings, writing down data, sorting the in-basket — are largely subconscious and seldom analyzed. Yet it is here that tremendous productive savings and benefits can be achieved if we can view many of our current tasks for what they are: wasted motor activity that reduces precious cognitive time.

Despite these hurdles, change in the form of automation and technological devices can be introduced successfully on the professional level now.

In preparation for the 21st century, Continental Bank has been installing large-scale office automation systems for the past three years. A worldwide management inquiry system is currently used by 4,000 managers and professionals worldwide. The electronic mail system disburses approximately 20 000 documents to 2,000 professionals a week. These two systems alone make available to the managerial and professional staff more than 30G bytes of corporate data.

Several hundred telephone answering devices have been installed throughout the corporation and handle up to 65% of the owner's incoming calls. Word processing centers scattered throughout the corporation handle increasing amounts of telephone dictation. Remote word processing centers are being tested and evaluated in two modes — in neighborhood suburban centers and in employees' homes. In each case, the employer is enabled to tap an attractive labor pool that was previously unaccessible.

Making Use of Early Adapters

The personality profile of the professionals is not the only cause of industry's slowness in successfully introducing the information technology on the professional level. Another cause is the failure on the part of the corporation to market and package these innovations creatively — in other words, to sell them effectively.

In today's world, the people easiest to reach and to impress are those members of the population who are eager to be first to try anything.

It also happens that the professionals of the 21st century are the chil-

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The 21st Century

dren of today — and today's child plays with electronic games and simple hand-held computers and uses minicalculators in school. The world of electronics will be a familiar and comfortable environment for the young people of the 21st century. They will have an adeptness and acceptance level far beyond that of most mature people today.

There are also people who are by nature early adapters — quick to see the benefits in a new product and eager to incorporate them into their environmental structure. They are tolerant of imperfections in a new product because they clearly see trade-offs in accepting some negative features for the sake of positive ones.

Implementation programs designed to get the involvement and participation of these early adapters stand a much higher chance of being warmly received and enthusiastically supported. An early wave of product acceptance is often sufficient in and of itself in winning over the next group of staff members.

Pilot Programs

This was the approach used by Continental Bank in introducing automation at the professional level. Small pilot programs with minimum funding and inexpensive equipment, staffed by a few highly enthusiastic people, were set up wherever the environment seemed receptive. Several pilot projects were started simultaneously, each using different approaches and different population segments. The success or failure of each was evaluated carefully.

Because the allocation of capital resources was small, it was unnecessary either to force success or to postpone the natural death of failure. Strategies could be altered easily; the process remained dynamic and flexible.

Pilot programs need not encompass an entire working group; they can be targeted at various individuals throughout the corporation. Some systems and technologies, such as a data storage and retrieval system or computer graphics, can be effectively utilized by the individual to his own benefit. Information retained has a particular virtue as a pilot project: It requires perhaps the least behavior change by all parties. If the user is able to obtain the information in either hard or soft copy on demand, the system can be treated the same as a paper-based filing system.

If there is no extra equipment cost, the pilot will be under less pressure to demonstrate benefits too early in learning curve. Later, when the benefits become clear to the early participants, others will become interested. Integration into the work environment will proceed on an individual basis with no need to mandate use until well on into the project. It may be necessary eventually to mandate use for specific purposes in order to eliminate production and distribution of older forms of information.

Graphics information is probably the next easiest technology to implement and early adapters can once again spearhead the pilot project. Because of the unlikelihood that existing equipment can be used, the cost of the pilot will be increased; this adds pressure for early demonstration of benefits. Therefore, before it begins, it is important to identify the clear benefits of the pilot project to the people involved. Anything less than an enthusiastic reception will endanger its success.

The next stage in the development of an electronic information system is word processing itself, which requires both organizational and behavioral changes affecting a whole group rather than individuals. Productivity increases when several people are served by a single word processing operator. This shift from "dedicated" to "shared" typing causes a fundamental change in the work environment and creates many conflicts. Fortunately, this transition has been made by many firms, and the newcomer has available valuable information from many sources.

The introduction of word processing quickly leads to better management of the logistics involved in supplying work from several people to the word processing operator. Telephone dictation is one very effective way to do this, but it requires new skills to be learned by an entire working unit — not just by the early adapters. There must be thorough training at the start of the project.

Audio and Electronic Mail

Audio mail requires the same skills that are used in telephone dictation. In both cases, the user must present a complete thought with no response from the other party. Individuals, of course, can install a phone recorder for their own use, but the real benefit does not develop until all the people in a working unit have the device and use it properly. If the normal verbal communication pattern of a peer group is to be covered properly, a pilot project must have approximately 20 units. (If a pilot project is too small, there will not be enough nonsimultaneous transactions to justify the project.)

There must be adequate training at the start of the pilot to get people to leave complete messages and return calls with complete messages. Because the entire interacting group must participate in order to achieve success, there must be careful follow-up to assure proper use of the system. This monitoring must be done by the early adapters within the pilot group itself; there is no one else available to do it at this stage of development. Initially, there will be many people with negative comments about talking to a machine. It is up to the participants, not the trainers, to explain the time savings possible for callers.

Perhaps the most difficult technique to introduce and institutionalize is electronic mail. Some users of the electronic mail will use it simply as a delivery vehicle, having someone else pull a printout of incoming mail and key in outgoing mail as if it were typed and conventionally mailed.

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Professional Environment in 21st Century

Eventually, most people will discover it is faster and more productive at least to read their mail on the terminal. Almost all users also will begin to key in one- and two-line components. In fact, a new problem will develop with a few people who key all of their own correspondence. These people must be encouraged to use telephone dictation for their longer documents in the interest of greater productivity.

As with dictation and audio mail, new skills must be taught to an entire work unit. But even more is required, because it is characteristic of written material to move through several layers of the organization. By cutting vertically through the organization, the pilot project is exposed to resistance from at least one and perhaps several high-level people who classify as slow adapters and present a situation that requires careful planning and execution. The pilot should have early support from high-level early adapters, but should allow sufficient learning time for the late adapters.

Even when fully developed, a system of nonsimultaneous communication will not, of course, eliminate the need to meet face-to-face on some issues.

In these instances, teleconferencing can be used advantageously to avoid time lost traveling to many of these meetings.

Picturephone services will be available not only among many cities, but, perhaps more important, among a firm's various locations within a single city.

Experience has shown that creative experimentation followed by careful evaluation of the results appears to be the appropriate way to introduce methods that help the professional become more productive.

The overall message is that electronics increases productivity by releasing individuals from the need to synchronize their activities with other workers. People do not have to be in the same place at the same time in order to work; they can proceed at their own pace regardless of others' schedules.

In light of the Continental Bank's experiences, I believe the manager-professional of the 21st century will depend heavily on microelectronics to remove artificial restrictions on mobility and communication. Professional energies and skills will be focused more sharply on the real cognitive tasks at hand. The creative manager, by using the tools that are appropriate, will outperform the traditional manager.

Considerable adjustments in personal style will have to be made, of course. As all information workers move toward the nonsimultaneous mode, the familiar management techniques of observation will no longer be adequate to control workers and events separated by time and space. Large central offices will begin to undergo change as fewer people use the facilities for face-to-face meetings and as the workday lengthens, with fewer people present at any one time.

As the centralized office loses importance, there are a number of things we must do. First, we must recognize the social as well as the business character of the office. There are many people who will be unwilling to forego the social aspects regardless of the various advantages inherent in working at home in their neighborhoods or in being highly mobile.

In the new professional environment, on-the-job training will be much less effective than it currently is in the office. For those professionals who choose to be highly mobile, a professional apprenticeship program might be required. A new employee might go through an orientation and training procedure that involves traveling with an experienced individual. During this time, the new individual would learn how to use mobile communications effectively and how to structure time.

Reviving What Was

Regardless of whether managers and professionals in the 21st century choose to stay put or to be highly mobile, some new skills will be required. Or perhaps it would be more accurate to say that some older, neglected skills will have to be revived.

At the present time, training in interpersonal skills is oriented toward meetings and negotiation. However, the effective use of dictation, phone recorders, pagers and electronic mail requires the presentation of a clear, concise message when there is no opportunity for the recipient to ask questions immediately. Skills that will be increasingly needed will be those that existed prior to the era of the telephone, when most business communication was done by letter.

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The 21st Century

They must be revived in the new era, when most business will be done by verbal mail.

Where workers do not choose to use the central office, the firm must provide for social aspects that are lost thereby. First is a need for formal identification with the firm and the unit, a problem sales organizations have solved with periodic sales meeting.

On a regular, formal basis, individuals will be required to come together weekly or monthly. At this time, identification with the firm and its goals can be reinforced. Through these meetings, people also experience identification and interaction with their peers.

A concept such as the so-called quality circle now being used widely in Japan might provide an answer to this general problem. There, a small group of people who share a common work experience meet regularly to discuss issues and problems that affect quality.

They are trained in various group dynamics and problem-solving techniques in order to facilitate the process of offering recommendations to management. These circles build rapport and involvement with one's co-workers while providing accessibility to top management through a structured approach.

In a dispersed office, concepts such as these will become increasingly important for maintaining loyalty and a sense of purpose.

Corporations will also make an effort to encourage their people to join neighborhood organizations such as homeowners associations, school boards and local service groups. This activity will not only replace the old work place social groups, it will also establish the firm's presence in a community.

As this transition takes place, firms will recognize the need to financially support their workers' membership in professional groups, local country clubs and civic groups.

The business environment that we have described for the 21st century represents an evolutionary development from that of today. No revolutionary breakthrough is needed to bring about the future office. Many firms will make incremental changes in office equipment and procedure — and discover after the fact that they have arrived there. But they will have arrived later and with less benefit than those that first set their sights on the future and then followed by controlling and directing the evolutionary process.

Technology now available can enable us to proceed with the professional work place of the 21st century. We need only to take advantage of the infrastructure we already have in place. In some cases, new equipment will be necessary, but this is easily obtained. Beginning the creative process of testing and experimenting with tools to liberate the professional from tedious office tasks is the only major hurdle to be overcome.

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Mertes is vice-president and general manager, systems, at Continental Bank in Chicago. ◆

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PERFORMANCE STANDARDS FOR CAPACITY PLANNING

One of the most outstanding individuals to come out of the American Industrial Revolution was a young man by the name of Frederick W. Taylor. Taylor's "scientific management" had a large effect on the tremendous surge of affluence we have experienced in the last 70 years, which has lifted the working masses in the developed countries well above any level experienced before, even that of kings and queens of old. Taylor's analysis of work and resultant method improvements created productivity gains unequaled in history.

His analysis of work in the 1880s was exemplified by his study of shoveling iron ore in a steel mill. In this study, he found gross inefficiencies in the actual process of shoveling. By breaking the motions and actions of the workers down into measurable segments, he was able to develop better work methods (something like tuning a computer) and standards of performance so that output could be judged on a day-to-day basis.

This work was finally completed, as we now know it, shortly after he died during World War I, at which time American industry in general began to adopt his principles. Some of Taylor's disciples carried on his work thereafter, notably, Frank and Lillian Gilbreath (who were the subject of a movie "Cheaper by the Dozen") and Henry Gantt, who initiated project scheduling in a Gantt Chart. The common interest uniting those people was the analysis of work and translating that analysis into more productive and efficient procedures and flows of work.

The analysis of work involves the following:

- The identification of all processes necessary to produce an end product or result.
- The rational (and manageable) organization of the sequence of operations so as to make possible the optimal flow of work.
- The analysis of each individual operation of process including measurement and historical trending.
- The integration of the above into an overall process of producing a product or result.

This established process has been used successfully for decades in American industry (and Japanese, and German, and . . .). It is my contention that now the data center has evolved to a point where this methodology may be applied in greater depth to realize significant economic benefits.

The role of the data center in the business that owns it has increased from simple payroll and accounting applications in the '60s (remember "tab runs"?); through inventory and distribution systems in the '70s; to on-line, real-time management and operational applications in the '80s.

A good example of the on-line operational application of the '80s is the automated teller systems in banks. In this case, the data center has gone to a point where it actually interacts with

Standards for Capacity Planning

bank customers.

The product of the data center is service, and with the proliferation of on-line systems, service has become a highly visible and much more tangible element.

In fact, service levels have become so visible to the world outside the data center that, to a large extent, they are considered the measure of the data center's performance. The perception of service falls into three basic categories:

- On-line response time.
- Batch turnaround.
- Availability.

(These were the first three items listed in a poll done in Arizona with 150 DP managers. A full list prepared during the 1981 EDP Performance Management Conference appears in Figure 1 on Page 41.)

When one of these categories is outside a user's expectation, the DP manager's phone begins to ring with complaints. Moreover, the business environment in which the DP manager now lives is one that expects him to manage his operation the same as any other functional unit of the enterprise.

At this point, many DP managers are beginning to feel the strain of trying to negotiate and maintain service levels without the benefit of having fully implemented traditional scientific management principles in their data centers. One major element of scientific management is the need to understand the elements of the service to be performed and the variables that would affect performance.

These variables have one of two sources: data center operation and user behavior. There are many data centers that have not yet quantified the difference in, say, response time caused by data center inefficiency as opposed to that caused by user behavior. This is because the analysis of work has not been related to these two factors.

These data centers are usually perceived by its users as being poorly run because all variances from negotiated response times are attributed to the inefficiency of the data center. When analyzing work, there are in fact only three universal kinds of deviations from a standard that will cause response time to be better or worse than planned:

- Volume variances.
- Mix variances.
- Efficiency variances.

The first two variances are attributable to user behavior. The third variance is the only one that can be attributed to the operating of the data center. In essence, the planning and anticipation of the volume and mix considerations are much of what capacity management is all about.

In this paper, I will explore methods of determining the relationship of volume, mix and efficiency on the current system and how we might predict performance at various levels. The goal will be to define performance curves giving standard levels of service variations as a result of volume and mix.

Volume Variance

Volume is a measure of activity in terms of jobs or transactions by job or transaction type. The various jobs or transactions in types result from the differences in computer resources consumed to process that particular job or transaction.

Differences in volume can be measured by comparing forecast or plan to actual. For example, the running of Job A123 resulted in the following volumes:

JOB	PLAN TIMES RUN	ACTUAL TIMES RUN	VARIANCE
A123	4	6	<2>

The volume variance in this case is expressed as two jobs over plan. In terms of resources expressed in service units it is two times planned resource per run of Job A123. Let's say Job A123 should use:

		(Thousands)
TCB	service units =	100
I/O	service units =	10
memory	service units =	60
Total	service units =	170

Then the volume variance is two times 170,000 service units or 340,000 units. This may be expressed in terms of dollars if a standard cost per service unit can be calculated and applied.

Now let's take an example where there is a volume and mix variance. Suppose that we have 22 jobs that require a total of 4,320,000 service units (an average of 196,364 per job).

The actual activity turns out to be 24 jobs requiring a total of 5,760,000 service units for a variance of 1,440,000 service units. The matrix of the above with additional information is then constructed as follows:

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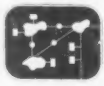

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JOB	UNITS P	A	V
A123	4	6	<2>
B357	8	3	5
C896	10	15	<5>
	22	24	<2>

JOB	UNIT SERV. UNITS
A123	170
B357	80
C896	300

TOTAL SUs (000)

JOB	P	A	V
A123	680	1020	<340>
B357	640	240	400
C896	3000	4500	<1500>
	4320	5760	<1440>

The volume variance is calculated:

Variance Units X (Planned SUs / Planned Units) = Volume Variance

<2> x 4320 / 22 = <392.8>

This variance is the amount of service units used over plan as a result of running more jobs than planned.

The mix variance is calculated:

(PLANNED SUs / PLANNED UNITS − ACTUAL SUs / ACTUAL UNITS) X ACTUAL UNITS = EFFICIENCY VARIANCE − MIX VARIANCE

(4320/32 − 5760/24) X 24 = <1047.2>

In this case there is no efficiency variance as yet. It will be brought into the problem later.

The mix variance is the amount of service units consumed over or under plan as a result of having different jobs run than were planned, which, in turn, consumed different amounts of resources. The summary of the variance is then:

Volume Variance	< 392.8>
Mix Variance	<1047.2>
Total Variance	<1440.0>

Now we can add another wrinkle to demonstrate an efficiency variance.

Available Software Tools

Level 1 Real-Time Monitors	Level 2 Continuous Monitors	Level 3 Predictive Models
MVS/TSO:	**MVS/TSO:**	
Resolve (Boole & Babbage)	CMF (Boole & Babbage)	Gamma (Boole & Babbage)
Look (ADR)	RMF (IBM)	
Omegamon (Candle Corp.)	TSO/MON (Morino Associates)	Best/1 (BGS)
QCM (Duquesne Systems)	QCM (Duquesne Systems)	
IMS:	**IMS:**	
Control/IMS Realtime (Boole & Babbage)	Control/IMS (Boole & Babbage)	
	Manage: IMS (Capex)	
	IMS Pars (IBM)	
CICS:	**CICS:**	
Resolve (Boole & Babbage)	Control/CICS (Boole & Babbage)	
Look (ADR)	PAII (IBM)	
Omegamon (Candle Corp.)	CICS Pars (IBM)	
	CICS/VS Monitor (Johnson Systems)	

Figure 2

Let's say that we have the following data:

JOB	UNITS P	A	V
A123	4	6	<2>
B357	8	3	5
C896	10	15	<5>
	22	24	<2>

JOB	UNIT SUs (000) P	A	V
A123	170	165	5
B357	80	100	< 20>
C896	300	500	<200>

JOB	TOTAL SUs (000) P	A	V
A123	680	990	< 310>
B357	640	300	340
C896	3000	7500	<4500>
	4320	8790	<4470>

In this case, the service units consumed per job were different than planned. Since we have kept everything the same except the actual service units per job, the volume and mix variances are exactly as previously calculated.

The efficiency variance is calculated by:

(Planned Unit SU$_1$ − Actual Unit SU$_1$) X Actual Units^1 = Efficiency Variance^1

+ (Planned Unit SU$_n$ − Actual Unit SU$_n$) X Actual Units$_n$ = Efficiency Variance$_n$

MEASURES OF PRODUCTIVITY IN DP OPERATIONS

RESULTS OF VOTING*

MEASUREMENT FACTOR	RANKING	VOTES
On-Line Response Time	1	198
On-Time Reports	2	160
System Uptime	3	141
User Satisfaction	4	137
Rerun Performance	5	137
Reports Distributed w/o Mistakes	6	56
Number of Interrupts In On-Line Service	7	55
Problem Resolution Time	8	47
CPU Utilization	9	45
Cost Of Operation	10	43
Actual Vs. Scheduled Runtime	11	39
Demand Batch Turnaround	12	34
Recovery Time From Failure	--	34
Time Sharing Interactive Response	--	30
Late Jobs Fault Of Operator	--	30
Outages By Category	--	29
Application Program Abends	--	27
Number Of Projects Within Budget	--	24
Hardware/Software Reliability, Intfac	--	23
Number And Time Of Tape Mounts	--	20
Jobs Completed Per Computer Hour	--	19
People Turnover	--	16
Absentee Rate	--	15

* Based on a survey of a meeting of data center managers at the 1981 EDP Performance Conference in Phoenix, Feb. 23-26, 1981.

Figure 1

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Standards for Capacity Planning

Plugging in the variables, we get:

(170 — 165) X 6 =		30
+ (80 — 100) X 3 =	<	60>
+ (300 — 500) X 15 =		<3000>
TOTAL EFFICIENCY VARIANCE		<3030>

The new total variance summary is then:

Volume Variance	< 392.8>
Mix Variance	<1047.2>
Efficiency Variance	<3030.0>
	<4470.0>

This says that the data center performance of running these jobs, especially JOB C896, suffered either because of:

- A bad application program.
- Some system deficiency.
- A bad estimate of what it would take to run the job.
- A bit of all three.

It should be noted that user behavior caused 32% of the total variance. Often, the user behavior element contributes even more to the total variance, especially at peak periods.

So far, the analysis of variance has focused on service units or the amount of work going through a data center. How do these translate to levels of service?

The data processing work plan basically consists of *putting out the required volume and mix of work* as a basic requirement, and *on a timely basis* as a second, but equally important, requirement. We can be sure that capacity has been exceeded when the data center physically cannot process the required work load even if it were to run a full three shifts per day, seven days a week. But below this level, there are many more considerations because there are practical limitations of available hours to do data processing work.

One of the serious limitations is the peak on-line requirement that occurs during the normal five-day work week. This is especially visible if the data center is very involved in the basic business of the company with which it works, such as a bank or department store.

What we are really talking about here are the user's work schedules and how that impacts the ability of the data center to deliver services matching their schedules as postulated in the *User Behavior Elasticity Theorem*, which states that *the degree to which the data center can influence end-user behavior is inversely proportional to the degree that data processing is involved in the basic business of the organization.*

In the banking industry, for example, where automated tellers are being implemented, the data center cannot influence the end users of this application to any noticeable degree because the bank's basic business depends upon having the automated tellers operating when *its* clients want to make a transaction.

On the other hand, a company producing buggy whips that has not integrated data processing into its basic business will tend to be much more flexible in terms of end-user behavior because production and distribution will continue whether the data center runs or not.

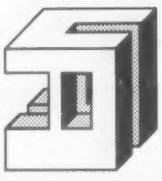
We are also talking about the necessity for conscious management decisions regarding the economic benefits of achieving a given on-line response time vs. the system costs that will be required to provide that level of response.

Software Tools

Those of us who have been tracking this type of data over time know what happens when a CPU gets over 90% busy and are well aware of exponential degradation of service levels that occur beyond this level. This is also true for many other areas within the system depending on where the system bottleneck is. Are there tools that will identify such sensitive areas in the system? If so, how might they be applied?

The software tools and sources of data needed to perform this kind of analysis are readily available. You probably have some of them installed on your system already. For the purpose of this paper, I will deal with those products that operate in the IBM MVS environment. However, other systems collect data on a similar basis, so the concepts presented here will apply to other environments as well.

In 1972, IBM introduced MVS with almost no software tools for control. Even today, IBM provides only a minimum of such tools. However, as MVS (and such subsystems as TSO, IMS and CICS) has matured and taken hold in the marketplace, a number of independent software firms have developed and are marketing many tools that are available for the data center to use. These tools also go a long way toward freeing the expensive and scarce systems program-



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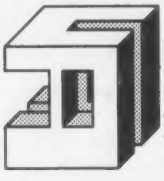

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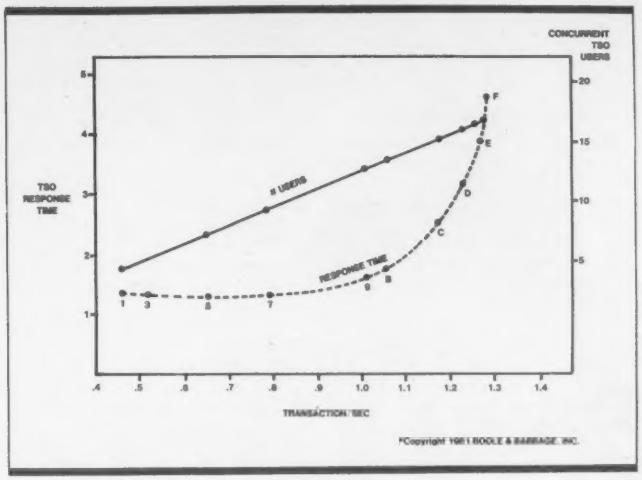

Figure 3

ming staff to concentrate on day-to-day system optimization and productivity, rather than long-term system monitoring and capacity management.

Since their initial introduction in the late 1960s, these tools have become easier to use and the outputs easier to interpret. The expertise of a veteran systems programmer is no longer required to implement effective performance controls.

Another major change is a conceptual one. In the beginning these control tools were introduced on a piecemeal basis. Now, however, many have been integrated into a cohesive architecture for capacity management at the system level. Such an integrated approach has the following distinct levels of data center control activities:

Level 1 — Systems programmers and operations personnel are working at this level on the day-to-day task of getting the work out and maintaining system availability and response to user-specified service levels. In this level of effort, real-time monitors show system and subsystem internal status so that problem areas may be detected and resolved. Early warning mechanisms driven by operator-defined thresholds simplify the task of identifying problem areas and systematically alert console operators. Another objective of this level is to optimize system performance by tuning.

Level 2 — The objective of this level is aimed at the next step above monitoring system internals. The major concern is achieving end-user service levels and establishing the extent of system availability for processing the various types of work. The basic orientation of this level is toward the fulfillment of end-user response and availability requirements. Standards of performance derived from the configuration capability and user requirements are established and monitored here. Basic cost accounting concepts are applied at this level to track financial performance.

Level 3 — This ultimate level is aimed at the DP manager's ability to predict the results of future work load and service level objectives based on various alternative hardware and software configurations.

This is a level of vital concern to the DP manager because a job well done here will substantially increase the chances of success in future demand situations.

If effective and sufficient effort has taken place at all three levels outlined above, the data center manager will have a properly tuned system and will be ready to take the next step into capacity management. Let's stop here for a moment and cover these basic tools.

Real-Time System Monitors

The word "real-time" is broadly defined to mean techniques relating to on-line display capability. In this case, a real-time monitor displays what is currently going on in the internals of the system. This is different from real-time inquiry to a data base of performance data that has been collected and can be displayed at any given time. A good real-time monitor will have the following major characteristics:

- Early warning mechanisms.
- User-defined threshold values.
- Clear and easy-to-understand screens.
- Graphics displays showing current system performance in current time periods.
- Menu-driven screen selection.
- Availability of comprehensive data for system event monitoring.
- Sufficient information for problem definitions, resolution and corrective action.

Early warning mechanisms and user-defined threshold values will relieve the system programmer of the task of continuously monitoring the system and looking for areas of potential or actual problems. By having warning messages flashed to the console operator, the system programmer would be called in only in the case of an actual problem where his skills are needed.

For example, a master terminal operator using an IMS real-time monitor may get a warning that an impor-

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tant short-running transaction cannot be processed because a long-running job of lesser importance is using the data base record needed by the short-running transaction. In this case, the problem can be resolved by the operator rather than calling in an IMS system internalist. The operator may cancel the long-running job, thereby allowing the short-running transaction access to the data base, and then reschedule the long-running job to be run later.

On the other hand, the master terminal operator may get a warning that scheduling failures are up 30%. Now an IMS system internalist is needed to determine why. By using the real-time monitor and the screen menu, he may quickly call up that information he will be needing to resolve the problem. Clear and easy-to-understand screens along with graphics displays will assist the operator in defining problem areas when he calls for assistance. Menu-driven screen selection assists everyone using the monitor to get where they want to be in terms of displays. The availability of comprehensive data in sufficient detail will help to minimize problems when they occur.

Figure 2 on Page 41 shows some of the major real-time software monitoring products available in the market today.

Continuous System Monitors

Whereas real-time monitors show information on system internals as they happen, continuous monitors gather statistics on user-defined key variables all the time that the system is operating. These statistics are available for presentation as batch reports or may be available on a real-time inquiry basis.

These statistics show how the system is being utilized over time and what kinds of demands are being made by the end users. A good continuous monitor will have the following prime characteristics:

- Low overhead to operate.
- User-selectable areas to be monitored.
- User-defined units of work and/or centers of activity.
- Exception reporting.
- History file.
- Summary and detail reporting.
- Extensive graphics and management reporting.
- Batch reporting as well as real-time inquiry.
- Low maintenance

When acquiring a monitor, whether real-time or continuous, a significant consideration is what system overhead will be incurred as a result of installing the monitor. Some monitors in the market require substantial system overhead and, in effect, disturb what they are measuring. *The object is to increase performance, not further degrade the system.*

The system overhead to run an MVS/TSO monitor, for example, should not exceed 1% to 2% in the continuous monitoring mode. Some monitors may also collect much more detailed data on an intermittent monitoring basis. In such an intermittent mode, the overhead should not exceed 5%. In the case of a subsystem monitor, such as IMS or CICS, the overhead will depend on transaction volume, but generally ranges 5% to 10% of that particular subsystem.

By having user-selectable areas to be monitored with user-defined units of work or centers of activity, the monitor will collect data that end users can understand in those areas that need attention.

Related to the user-defined variables, standards of performance that can be monitored will yield reporting on an exception basis. Why collect detailed data when the system is meeting standards? A history file of the collected data (both date and time stamped) will provide work load data over time. This will assist the data center management in characterizing the user work load and relating this to future system demand. Summary and detail reporting enable the data to be presented to the system programmer or the operator manager, depending on the type of report needed. Extensive graphics and management reporting will be directed at service-level performance and work load behavior.

Batch reporting as well as real-time inquiry allow immediate or day-after data analysis and reporting.

Finally, because the monitors extract system data (and there are many techniques for doing this) low maintenance is a critical item. The product should be usable through releases of the operating system and its subsystems. Some of the major continuous monitoring software products are also shown in Figure 2 on Page 41.

Predictive Models

When the data center has implemented the first two levels of system

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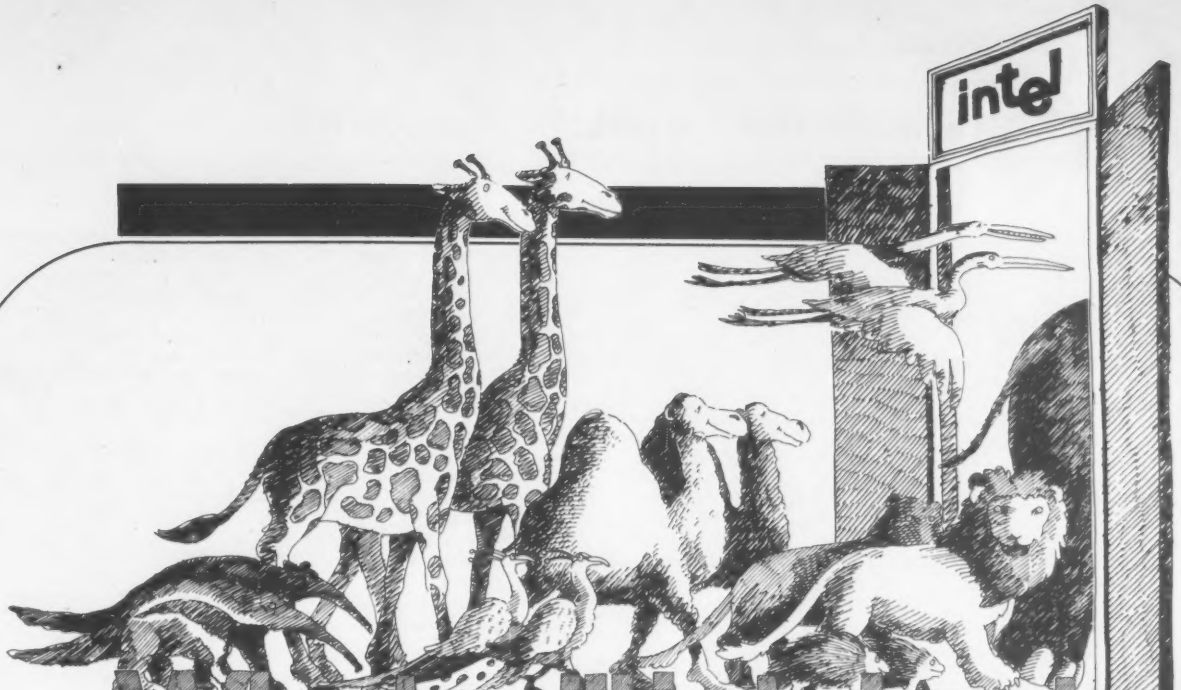

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performance management, the next logical step is to relate user work load and service demands to the capability of the system. The first step in predicting system capability is to know what the system can do now. Having implemented performance reporting in Level 2, there will be data relating to work load characteristics and service level achievement.

First, we must assume that the system is properly tuned from the first level of instrumentation. A second assumption is that the work load has been shifted to the extent possible (i.e., batch work at night so as not to interfere with on-line work). At this point, the theorem of User Behavior Elasticity applies. The next logical step is to develop operational standards of performance in terms of service levels based on the current configuration and end-user service level objectives.

In the case of predictive models, such questions as "What effect on service level will be experienced by adding another channel or Dasd device?" can be modeled and the results calculated against the current work load. Future anticipated work load growth can be fed to the model to see future service level achievement with the current system.

Then, alternative hardware and software options may be considered to find what is needed to achieve negotiated end-user service level requirements. Additions to the current system or other alternative systems may also be modeled to measure the impact. Figure 2 on Page 41 shows the two basic predictive models being marketed now.

The major characteristics of a good predictive model are the following:

- Easy to use.
- Will distinguish the various hardware and software characteristics of available products.
- Can easily integrate user historical data to define work load characteristics.
- Economical to run.
- Easy to interpret reports.

The first and foremost requirement is that the model be easy to use. This will reduce the need for highly technical systems people or, at the very minimum, a mathematical theoretician to use the product. The model should be usable by a trained business analyst.

The predictive model ideally will have a library of the various hardware and software alternatives available to the data center, so that the analyst can play "what if?" games. That is, various configurations can be matched against various work load and service level requirements to determine which configurations would be optimal.

This type of analysis lends itself extremely well to the decision making needed in the process of appropriating capital goods (i.e., data center hardware or software). From this data, various suitable configurations can be selected and the cost-effectiveness of each evaluated. The cost of various user service levels may also be calculated. Both the capital and service analysis will assist in establishing the financial requirements for the data center.

It is important that the model be fed from the second level monitors so that work load data can be easily integrated. This may be used to define current standards of performance as well as defining trends for predictive modeling.

The model should be economical to run, that is, it should not consume much computer time. Since this process will be interactive and many passes of the model will be required to determine the new performance curve, each pass should run in a couple of minutes or less.

And finally, the output must be easy to interpret and readily presentable for management reporting. Again, a business analyst should be able to interpret the output and be able to input various alternatives as a result of the output from any given pass of the model.

Setting Standards

The objective of this measuring, analyzing and modeling will be to derive performance curves that can become operational standards of performance that show the relationship of service level achievement vs. user behavior. It is an interactive process that involves tuning and end-user negotiations until finally an agreed standard of performance has been set. However, the standard is dynamic. User-controlled variables are, in fact, the various levels of volume and mix for each of the various categories of work.

In this case we will discuss TSO transaction response as a function of the volume of user activity. The data for this graph may be obtained from CMF, RMF or SMF. In the case of a

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"A one-byte change on Sunday has caused a system to come to its knees on Monday morning."

DOS or in non-IBM environments, the system log that records the volume of activity and system resources consumed should provide the necessary data. A system work load summary should provide the following data:

- Volume of transactions by performance groups.
- Service units used in each system area.

The CPU utilization report should show:

- CPU busy data.
- CPU queue data.

A TSO subsystem performance report should show:

- TSO response by time period.
- TSO response by command.
- Concurrent TSO users.

The above data was fed into the SAS statistical program to determine which data showed a relationship between TSO response and another variable. The variable with the closest relationship turned out to be the CPU queue time, which is directly affected by user volume and mix. As calculated by Little's Rule, $L = \lambda Q$, or the mean length of a queue is equal to throughput times queueing time.

In the case of our system, we are currently CPU-bound, so this is not a surprising bottleneck.

Using historical data, system interrelationships with user behavior can be derived. However, this kind of data tends to be linear and does not answer the question of how the system will react to user behavior at levels not yet experienced.

A third problem is that the system is never exactly the same from one period to the next. For this reason, it is extremely important to correlate performance data from the system to data from the Change Management Tracking System. The Change Management Tracking System is the repository of all hardware, software, and applications modifications made to the system.

There have been many times that a one-byte code change on Sunday night caused a system to come to its knees on Monday morning with resultant days of analysis before the change was found. Each system change needs to be documented and available for analysis when performance data shows a major deviation.

Because graphing historical data will not always answer the questions

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of future system behavior for future user work loads, a model is often used to simplify the process. By using a model, curves may be defined for each system limitation as well as an overall curve for the present system capability. This requires many iterations of a model to define the points on the curve and even more iterations to define other possible curves. It is also important to validate the model to actual system results.

If indeed the model can be validated and the results are consistent, we have in fact defined an "operational standard." "Operational standard" as used here means that there is a standard performance characteristic for a given level of user activity. This becomes an extremely powerful tool for negotiating service levels with users. A major misunderstanding with users can be avoided if they realize that for some levels of user activity, response will be lower.

Figure 3 is a performance curve of the Boole & Babbage data center. This system is comprised of:

CPU	M60 (370-148) plus 6M-byte memory
DISK	6x 3330 8x STC 3630 (3350)
TAPE	3x STC 4534
CHANNELS	4 plus byte multiplexer
OPERATING SYSTEM	MVS/JES2/TSO/SPF/VAM/CICS

Response time degrades significantly after 20 concurrent users and 1.1 transactions per second. In further analysis of our case, we found that we are CPU-bound.

This means that as the CPU resource is consumed by a work load, degradation of service will be a direct result.

The next step in this simulation will be to model the performance curve of the new system. We may then find some other system bottleneck such as I/O or direct-access storage device.

In the meantime, we now have our operational standard of performance for TSO.

Future of Modeling

The modeling of a work load against a given system is not only necessary, but is feasible with currently available tools and technology. The computation and comparison to planned performance curves has value in determining:

- Data center efficiency.
- The effects of user behavior (volume and mix).
- Benefits of tuning.
- The ability of the data center to meet various levels of activity.
- The benefits of various systems alternatives.

Because of these benefits and the fact that future models will get even more involved in simulating operating system parameters, performance curves should be monitored on a real-time basis.

This means linking the Change Management Tracking System and real-time system monitor so that early warning mechanisms can be implemented.

By monitoring operational standards, both on a continuous after-the-fact basis as well as in a real-time mode, the data processing operation has implemented an important element of scientific management.

The work analysis is done by the system itself while the manager deals with the question of user behavior and the integration of DP into the business.

Vincent is manager of the Educational Services Division of Boole & Babbage, Sunnyvale, Calif. ◆

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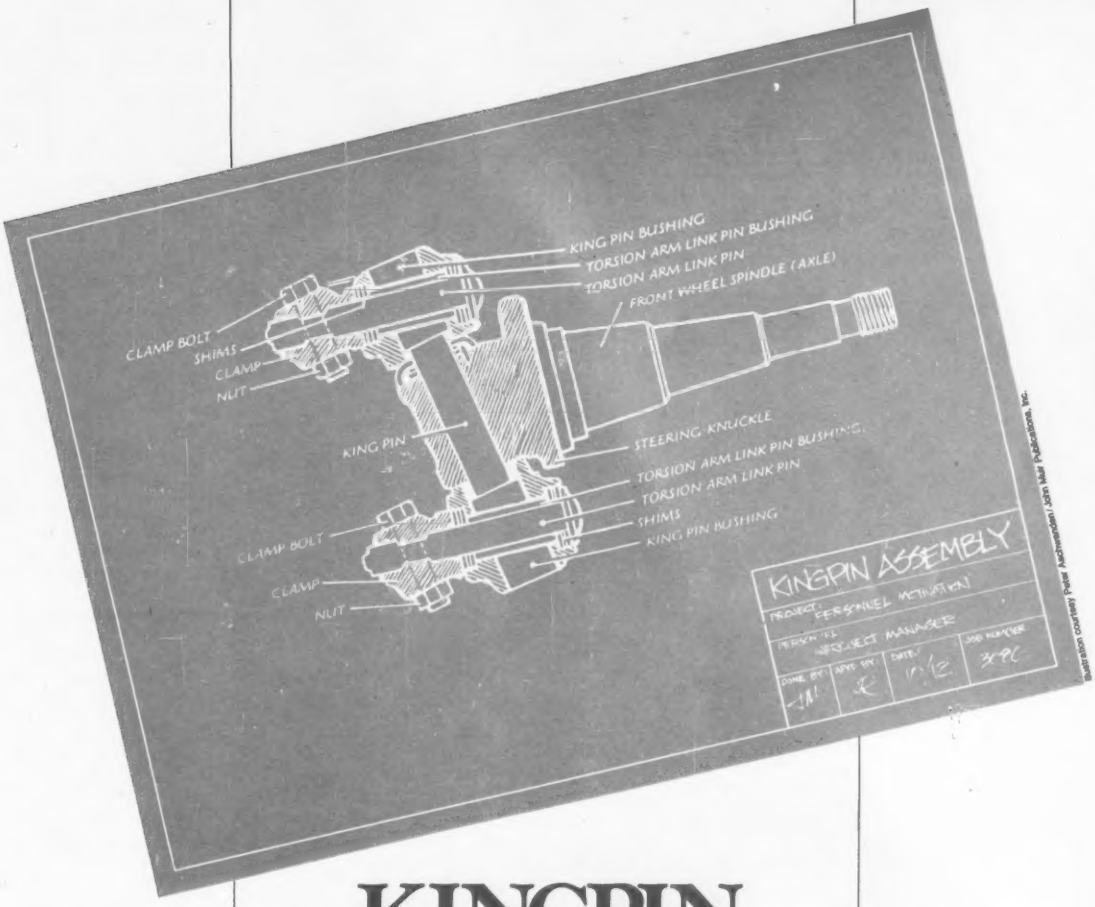

KINGPIN IN PERSONNEL MOTIVATION

Kingpin — "The vertical bolt joining a body to the crossmember — serving as the pivot."

Few would dispute that the project manager (PM) is pivotal to successful and cost-effective project completion. Without a motivated project manager, it is doubtful that the project team will be motivated. Yet, recent studies have shown many project managers are not receiving job satisfaction. It is unlikely their teams are getting effective leadership to ensure motivation and productivity.

The problem of PM job satisfaction was revealed in our national surveys of the computer field throughout the past two years. The situation was a surprise to us; it was not one of our prestudy hypotheses. Moreover, the cause is not the usual cause of job dissatisfaction. The answer has taken four months of analysis of our data base on more than 1,500 supervisors and managers in the computer field. It was finally

Kingpin in Personnel Motivation

pinpointed through cross-correlations on the more than 40 variables acquired for each person taking our survey.

Before these conclusions are discussed, it is important to explore the conditions that caused the problems.

The Problem

Figure 3 on Page 52 illustrates the problem.

It represents responses of personnel in four job categories to our Job Diagnostic Survey for Data Processing (JDS/DP):

- Computer operators.
- Programmers.
- Analysts.
- Project managers.

Our data base on those jobs contains information on more than 4,000 people and has high statistical precision and validity.

The top curve represents the survey mean for Job Motivating Capacity (JMC) for each job.

The values for this summary-type variable are obtained by a computation using survey responses about five attributes of the job:

- Skill variety.
- Task identity.
- Task significance.
- Autonomy.
- Feedback.

Prior research has shown that a job rich in these key components produces motivation.

The top curve shows that the average project manager believes his job contains these key components to a greater extent than do analysts, progammers and operators. The result is high JMC.

The lower curve is perplexing. Growth in job satisfaction accompanies progression through the career path — until the project manager position.

For a large body of project manag-

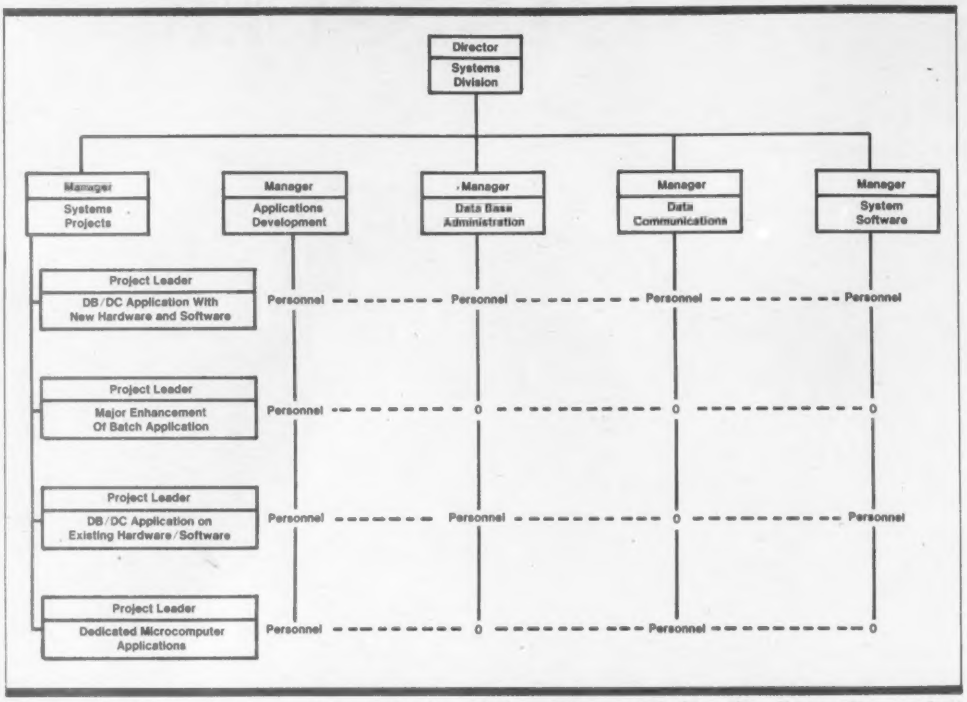

Figure 1. Textbook portrayal of matrix organization — fails to reflect myriad of interfaces/interactions required of project leader.

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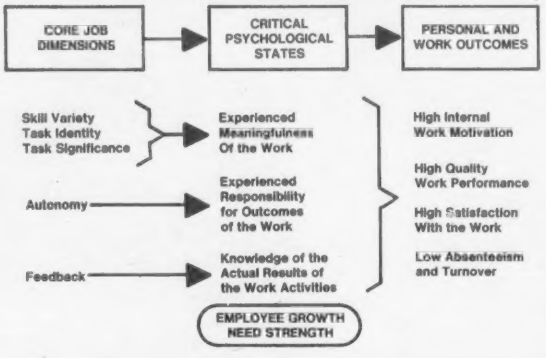

Definitions of Core Job Dimensions:

Skill Variety: The degree to which a job requires a variety of different activities in carrying out the work, which involve the use of a number of different skills and talents of the employee.

Task Identity: The degree to which the job requires the completion of a "whole" and identifiable piece of work — i.e., doing a job from beginning to end with a visible outcome.

Task Significance: The degree to which the job has a substantial impact on the lives or work of other people — whether in the immediate organization or in the external environment.

Autonomy: The degree to which the job provides substantial freedom, independence and discretion to the employee in scheduling his work and in determining the procedures to be used in carrying it out.

Feedback From the Job itself: The degree to which carrying out the work activities required by the job results in the employee obtaining information about the effectiveness of his performance.

Model of Motivation

"One major finding of our national surveys was low Social Need Strength of people in the computer field"

ers, a reversal occurs, reflected in the downslope (for Group 2) shown in Figure 3.

However, for another group of project managers (Group 1), job satisfaction does not decline.

Understanding the cause of this problem is facilitated through better understanding of core job dimensions that produce motivation and increase productivity.

Motivation Model

The model of motivation is shown in the box on Page 50. Studies by behavioral scientists Herzberg, Lawler, Hackman and Oldham isolated these five job dimensions as those essential to motivation. The work of Fitz-enz confirmed that the same variables are a key to motivation of computer professionals. The left side of the model of motivation lists the five core job dimensions. They are defined at the bottom of the box.

If a job contains the proper number of these job dimensions, the positive outcomes on the right side of the model can be expected. However, the outcome is affected by the individual's need for growth, the interviewing variable shown at the bottom of the model (GNS).

A job rich in the core dimensions will motivate a person with high growth need strength. Our research has shown the typical PM's job is rich and the typical PM has high GNS — a good match. Therefore, other factors have caused the job dissatisfaction.

Matrix Organization

A principal cause of reduced job satisfaction on the part of many project managers is the way their companies have implemented the matrix organization.

Figure 1 on Page 50 illustrates the matrix organization used by many companies. The structure includes both functional and project organizations.

Technical managers are assigned for each technical area, typically one for each of the following: application development, data base administration, data communications and system software. This approach uses the traditional vertical organization. The second layer of supervision, project management, has a horizontal orientation.

When a project is originated, personnel are temporarily reallocated from the vertical organizations to provide the proper pool of talent. For example, the data base application shown for Project 1 pulls people from all four technical organizations, while the dedicated micro/mini application in Project 4 utilizes personnel only from the application development and system software areas.

There are two principal benefits of the matrix organization. The first can be labeled a "myopic" view — the project manager has a specific goal orientation and wears blinders to all others.

His sole concentration is on installing one system within cost and schedule constraints — his attention is not fragmented among a number of projects, but is centered on one task. He interacts with only one user (or user team). Therefore, probability for completing a project on time is increased.

The second benefit can be labeled "conflict" management. The conflict for resources between the project manager and the technical manager keeps continual attention focused on the project, heightening the probability of schedule compliance.

The project approach has worked well in other industries — particularly in the construction industry and the aerospace industry, where schedules are of prime concern. It can work equally successfully in our industry — if management adapts it to the special characteristics peculiar to the computer field and its people. If those special characteristics are not taken into consideration by the approach in which the matrix organization is installed, the result will be PM job dissatisfaction.

However, the results can be positive, as demonstrated by the high job satisfaction of project managers in other organizations. These special characteristics of personnel in the computer area are discussed next.

A unique characteristic of personnel in our field has a major impact on job satisfaction of project managers. One of the major findings of our national surveys was the low Social Need Strength (SNS) of people in the computer field — relative to the SNS of people in other fields.

SNS is a measurement of the strength of a person's need to interact with others. There is a significant disparity of SNS between computer professionals and other professionals. On a scale of 7, SNS for other professionals is 5.48. For analysts and

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until someone invented the screw.
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Kingpin in Personnel Motivation

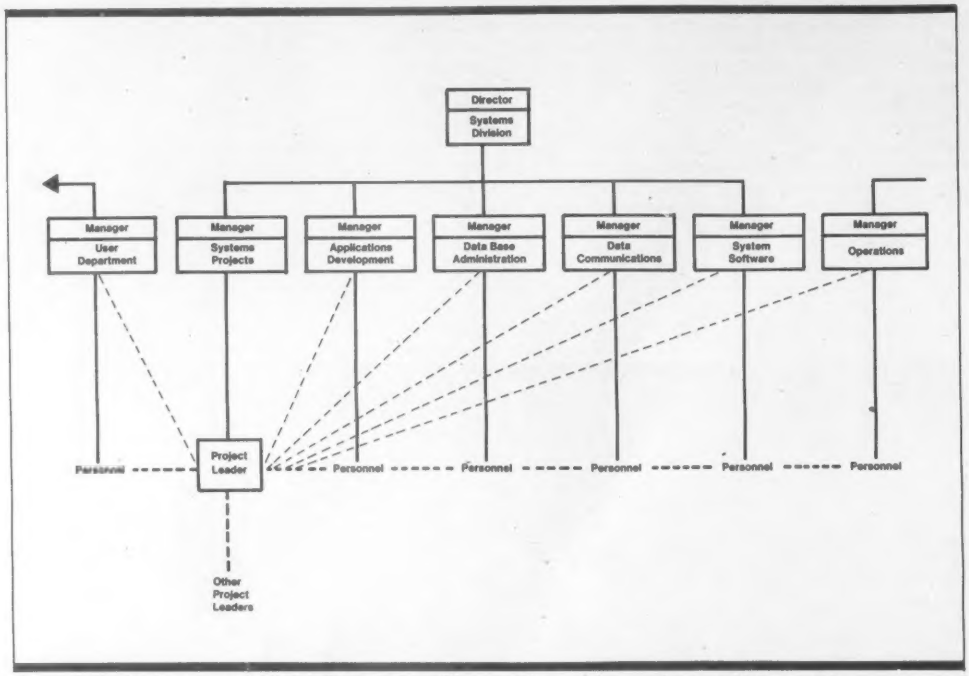

Figure 2. Realistic portrayal of interfaces and conflict possibilities for project leaders in a company using the matrix organization approach. Project leader must negotiate with a variety of higher level managers and must motivate team members who typically receive their raises and promotions from other managers.

all levels have significantly lower SNS than their peers in other parts of the company. In contrast, sales managers have high SNS; they need and seek frequent interaction with others: peers, subordinates and bosses.

People with low SNS do not seek interaction so frequently, yet the task of project management requires constant interaction. Communication and behavioral skills are essential for effective supervision, yet people in our field do not come by these skills as naturally as do people in other professions.

Resulting Conflict

Compounding the problem is the matrix organization, which requires more interaction than the traditional vertical organization. The textbook portrayal of the matrix organization (Figure 1) fails to recognize the many interfaces and interactions imposed on a project manager.

Figure 2 shows the real situation. The PM must interact and negotiate effectively with the customer (user), with the supplier of resources (technical managers) and with operations.

The project managers must also be able to motivate people who are temporarily assigned to them, but who receive their raises from their home bases. The matrix organization forces continuous social interaction on people who are not seeking it. This does not mean we should avoid the project management approach; it just means our personnel need additional preparation to be successful as PMs.

Figure 2 also illustrates the second major problem for our project managers. That person typically is negotiating with a manager at a higher level in management structure — both users and technical managers. The PM is at a disadvantage in having prime responsibility for a project, but the authority of only a lower level management position.

Resolution of Problem

Use of the JDS/DP in more than 100 organizations has revealed an inter-

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programmers it is only 4.2, a highly significant difference. Although some professions attract people who have a high propensity for, and reinforcement from, interaction with others — people in our field do not exhibit this characteristic.

What impact does SNS have on project management? A significant impact — seriously affecting the approach to organization and management of a project. The low SNS of computer personnel is not confined to nonsupervisory employees. SNS for DP management is equally low, compared with managers in other parts of the company. Our data base contains information on three levels of DP management;

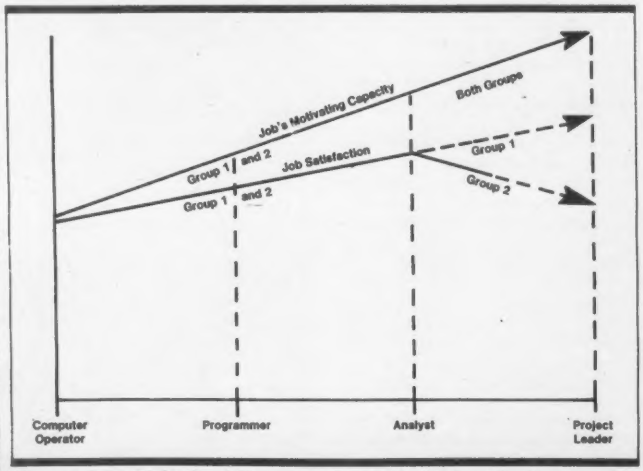

Figure 3. Job satisfaction (JS) compared with the job's motivating capacity (JMC). For a large group of personnel (Group 2 above), job satisfaction declined significantly as a result of performing the project leader job.

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Greg O'Reilly, Systems Manager, Figi's, Marshfield, WI "We have gotten many applications going because UFO is so easy to use... jobs such as on-line credit card verification, file maintenance utilities created without CICS mapping, and many small requests by user departments. Most of our people aren't CICS trained."

Steve Harris, Director of MIS, Children's Hospital, Boston, MA "The first thing I did when I joined the hospital was buy UFO because I used it for more than a year at my last job; we are simply more productive in our on-line development with UFO. Many projects which were too expensive with traditional CICS technology become cost-effective when you use UFO.

"UFO trades off machine power for people power. While it takes a reasonable amount of training to teach someone UFO, you certainly don't have to be a CICS programmer to use it."

Ken Cyrus, Database Manager, Carter Machinery, Salem, VA "We were looking to get on-line transactions up faster than under standard COBOL. We had DMS installed for two weeks, but got absolutely nothing done. Within the first two weeks with UFO, we had at least 20 to 30 VSAM update/inquiry programs up.

The most surprising thing about UFO was its execution speed. I never figured anything interpretive could execute as fast as it does."

Frank Scafidi, Director of Technical Services, University of Pennsylvania, Philadelphia, PA "Two years ago we had 10 applications up under CICS. Today, we have over 50 applications up under UFO. We never could have done so much without UFO."

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Kingpin in Personnel Motivation

esting pattern. Some companies establish the position of project leader as the first step on the supervisory career ladder. Other companies do not assign people to project management responsibility until the third or fourth step on the supervisory career ladder.

Job Satisfaction

The effect of the difference in these two approaches on job satisfaction is dramatic and is the difference depicted in Figure 3. Group 1 represents the responses of personnel who become project managers as a third or fourth step supervisor. Group 2 represents personnel whose first supervisory job is project management.

Why is the difference on job satisfaction so drastic? There are two important reasons:

1. Conflict management requires a more experienced manager. Project management is a tough job. Because of the conflict environment, the job of project supervisor is more difficult than that of technical supervisor. The horizontal orientation of project management requires a person whose primary skill is management and whose secondary skill is technical ability. The vertical orientation of a technical manager has these priorities reversed. Therefore, the more experienced manager is needed in project management.

After seasoning in two or so levels of supervision, most people can make an effective transition to project management. When such a career path occurs, the project manager is more apt to perform well and to obtain high job satisfaction. Conversely, people who have to tackle the toughest possible supervisory job as their first job in management may not survive at all. One who examines the project management approach in other industries, such as construction and aerospace, finds that experienced rather than inexperienced managers are assigned to project management.

2. Low SNS people need more formal preparation for project management. The typical user is a middle manager, not a first-line supervisor. The research shows these people also have much higher SNS than their counterparts in DP. They call frequent meetings — the best avenue to provide social interaction. They insist on more communication and feedback than low SNS managers of DP projects.

If this is the DP project manager's first supervisory job, he is at a double disadvantage:

- He is required to negotiate with a more experienced manager — both the user and the technical manager.
- He is required to motivate people, only temporarily assigned, whose first allegiance is to the technical manager who gives them raises and promotes them.

The tasks of motivation under these circumstances require more formal training in communication and behavioral skills. Many of our personnel come from math and computer science backgrounds where behavioral science was not included in their academic programs. However, even those with degrees in business administration may be low SNS personnel, so that additional behavioral training is required for them to become effective communicators and motivators.

Some companies have depended upon the corporation training department for all management training. In these companies, technical training is controlled internally by the DP department, but all management training is the responsibility of the personnel department. As shown by the statistics above, DP personnel have special characteristics that need specially tailored courses. If the central training department is not responsive to the special needs, the DP department needs to consider conducting its own supervisory training.

Conclusion

Ever been forced to eat salt-free food, or Mexican food without pepper or pizza without garlic? It is remarkable how a small amount of spice affects the entire outcome of a meal.

The portion of a project's budget consumed by the PM's salary is also miniscule — similar to the amount of spice in our food. The PM's salary is a minor percentage of the labor cost of a project, yet the project outcome is more dependent on this particular component than any other ingredient in the project.

Motivating the PM is essential to successful and cost-effective project implementation.

Hence, the title of this article. The project manager is the kingpin to DP personnel motivation and productivity. Loosen that pin and the whole project is jeopardized.

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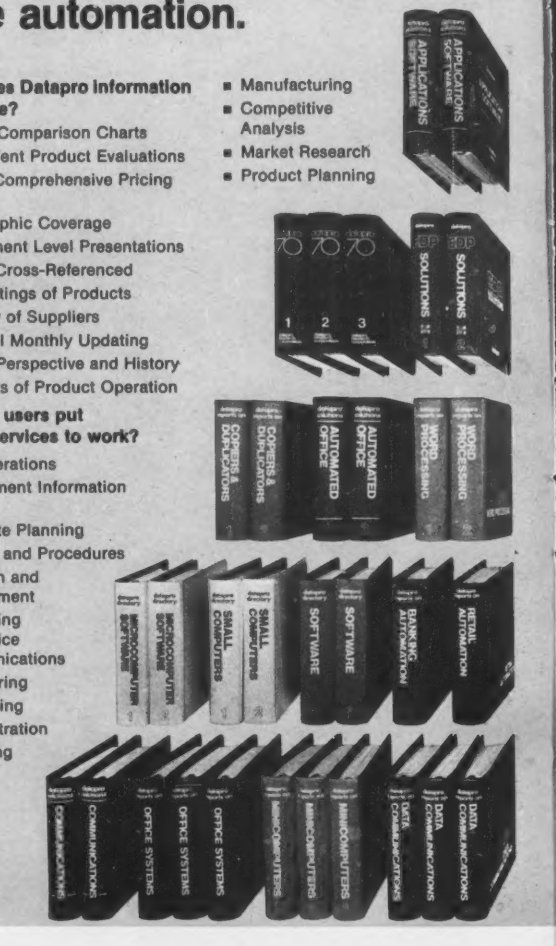

"To 'grow' effective project managers, ... behavioral/communications training and careful nurturing is required."

To "grow" effective project managers, a combination of behavioral/communication training and careful nurturing is required. Our JDS/DP data base shows that many organizations have been successful in their project management approach.

Proper training in the behavioral/communications skills to overcome low SNS and proper design of the matrix organization can produce project managers who perceive their jobs to be challenging and satisfying. Using this approach can produce the positive result shown by Group 1 in Figure 3.

The conditions described above, of improper matrix organization coupled with the PM's low SNS, can lower job satisfaction. In some cases, it causes project manager attrition. Two real-life examples are described below.

The Carnivorous Manager

The new project leader had been promoted because of his nice mix of technical skills and company perspective. He attended a four-day project management course taught by a nationally recognized training company. His promotion was announced too late for him to attend the first-line supervisor course offered by the company personnel department each quarter. He was scheduled to attend the next offering. His user was the manager of production planning. The project team was to develop a materials requirement planning (MRP) system.

The user manager was the typical production manager — outgoing, up-from-the-ranks, table-pounding, insistent that his system be implemented "correctly and on schedule." To make sure this result was attained, he "managed" the project, ensuring that it was, in his own words, "tightly controlled." He called frequent meetings of production and system team members and insisted on being involved in detailed aspects of the system design. The new project leader was overpowered and underrealized. He left the company less than six months later.

This example of the "carnivorous" user manager is not unusual. These managers are more experienced and want to control the project — they can intimidate and frustrate a new project manager. By assigning projects to higher level, more experienced supervision, a different result can occur.

The Many Meetings

The second example involves a new project leader with a degree in systems analysis/design from a leading school of business. Despite his good foundation in the behavioral sciences, his SNS was typical of that of others in our industry. The behaviorialists tell us that SNS tends to be innate or environmentally acquired at a very early age.

Despite his previous satisfactory performance as a systems analyst, the new PM was not performing well. His supervisor called him in to discuss the situation.

"I'm forced to spend over 50% of my time in meetings — with users, with technical managers, with operations personnel. Often these meetings are called by other people. They are not run efficiently and waste time I should be spending with my own team," was the new project leader's response.

His high GNS reinforced his low SNS in this situation. High GNS compelled him to push the technical aspects of his job. Meetings detracted from that objective. Nor did he require meetings for social interaction. Both users and operations personnel have much higher SNS and find meetings an excellent device to fill their need for social interaction.

After six months, this employee asked to be transferred out of the PM job and back to a nonsupervisory technical job.

Prevention Measures

Two things might have prevented his attrition:

- Training in "recognition of" and "how to deal with" his low SNS.
- Emphasis by his supervisor that high GNS and low SNS are not incompatible with the PM position.

The supervisor should be able to show the high GNS project manager that meeting project objectives requires close rapport with users and that meetings may be the best means to establish that rapport. One PM even "sacrificed" and began reading the sports page to be able to have additional common grounds for communication with his users.

Couger is a professor of computer and management science at the University of Colorado. His latest book, Motivating and Managing Computer Personnel, *coauthored by Robert Zawacki, is published by Wiley-Interscience.* ◆

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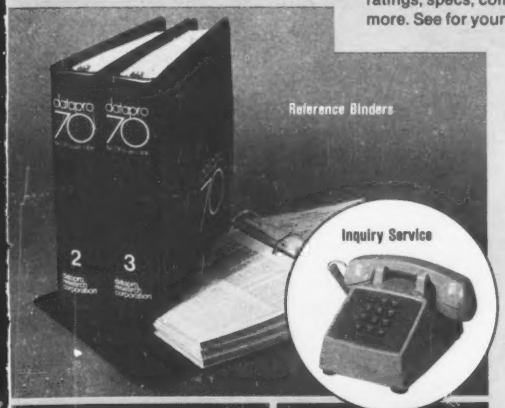

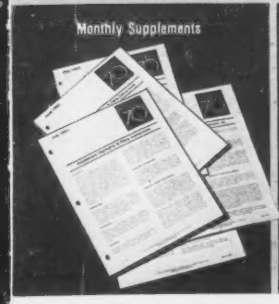

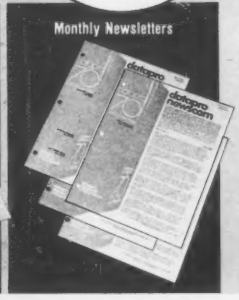

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DBMS Hoax?

DEC-computer sites purchase bogus relational system.

Fortune-500 companies did it. So did prestigious universities, banks, newspapers, a large computer manufacturer, and many others. All of them bought a software package that they believed was a relational DBMS. Why this happened is a lesson in the history and perception of relational systems.

IBM AGAIN

Relational systems were conceived in 1970 by E. F. Codd, an IBM research scientist. The advantages of data management software had been known for years. But Codd invented a concept of looking at data and information in a simple but powerful way.

Codd discovered that all data could be organized into tables, or flat files, in a normalized form. He called these tables relations. Around this framework, he invented an easy-to-use language to manipulate and extract data from relations. Codd's conceptual breakthrough accommodated all data structures that conventional DBMS's did. And he discovered that inexperienced people could understand his concepts as easily as software experts.

THE FLAW

Codd's scheme required an operation called JOIN. This facility dynamically merged related data items from several tables into one logical table whose characteristics were identical to those of a physical table. But here he encountered a major problem.

The JOIN operation was impossible to implement efficiently with then-current software methods. An efficient, run-time JOIN required special hardware called a content-addressable memory. Such hardware would take years to develop. In fact, commercially-available content-addressable memory still does not exist.

In 1971, our company, Software House, began developing a relational DBMS for large DEC computers. We believed that our System 1022 DBMS would overcome hardware constraints with clever software techniques. It was a bold gamble.

After five years of development, Software House had failed. At that time, System 1022 had many relational features. According to Codd's definitions, however, System 1022 was not relational. Nevertheless, our president believed that System 1022's few relational flaws would be masked by its many relational features. He decided to market it.

NO JOIN OPERATOR

For interactive users, System 1022 provides a flexible and easy-to-use language for on-line data-base queries and updates. Boolean queries with multi-key and partial-key searches happen in seconds, regardless of data-base size or query complexity. The secret is System 1022's proprietary, inverted-file indexing and access method. And during data base updates, System 1022 automatically and efficiently maintains its data-base indexes in optimal form, without degrading subsequent retrieval speed. So you don't have to periodically rebuild your data-base indexes or spool your data-base updates—major flaws in other DBMS's.

System 1022's access method takes the place of content-addressable memory. It may not be as fast as the hardware, but when you see it in operation you'll agree that it's more than fast enough. However, no explicit JOIN operation exists. Instead, a powerful MAP command quickly retrieves related information from various tables. But more on that later.

NO PASCAL

With System 1022's Host Language Interface, you can produce tailored data base application environments in COBOL, FORTRAN, MACRO, and BASIC. So you can exploit operating-system features like command scanning, IPCF, and DECNET in your applications. You can even write your own interfaces to other software packages and other host languages.

System 1022's Host Language Interface was not designed as an afterthought. All of the features of System 1022's interactive environment are also available in the Host Language Interface. For example, a simple subroutine call invokes the 1022 Report Writer and then returns to the host-language program at its next statement.

RECURSION

Some DBMS's support only sequential or two-level hierarchical data structures. This severely limits the variety and sophistication of your applications. A comprehensive data base system does more.

System 1022 supports full hierarchical, network, and recursive data structures, for virtually any application. Its relational approach combined with this inverted-file access method offers high performance, high reliability, and data integrity. System 1022 handles a complicated bill-of-materials application as easily and efficiently as a simple mailing list application.

System 1022 also gives you both data independence and structure independence. As your requirements evolve and change, you can add new fields, new record types, and new relationships to your data base, and not have to recompile or relink your programs that access the data base. But that's not all.

With System 1022's efficient MAP facility, you can navigate your data structures from the interactive environment as easily as from your host-language programs. Of course, in both environments, you can access and update several record types and several data bases at once, even from many processes simultaneously.

APPLICATION PROBLEMS

System 1022 is more than just a DBMS. There's a report writer with pretotaling, text scrolling, context independence, and unlimited control breaks; audit trail journals for restart and recovery; field-level security based on user ID, class, and passwords; direct access to your existing COBOL files; utilities to load your data base, add fields, extract subsets, perform complex statistical analysis, post transactions; and much more.

For most jobs, you don't even need to write a program—System 1022 already provides the utilities. And you can easily teach your users to do their own development, reporting, and data maintenance. So you can centralize or distribute your information management as much as your needs require.

UNUSUAL QUALITY CONTROL AND SERVICE

The other side of software features is software service. Unlike other software companies, we take software bugs for what they really are—software mistakes. And we've spent man-years developing proprietary, automated software testing tools to eliminate such mistakes. We put each version of System 1022 through a comprehensive, 15-hour computerized check-out on our in-house computer. Only after it passes this checkout with a perfect score is it released to our field-test sites. And only after a successful field-test is System 1022 released to you. System 1022's reliability is well above the industry average.

Despite our best efforts, some mistakes elude us, so we take them seriously if you discover them. We realized long ago that a System 1022 software mistake can shut down a critical application in your shop, costing you both money and angry users. If you discover and report a critical mistake that we've made, our maintenance and support staff promptly investigates it for you. Then they provide you a way to conveniently get around the mistake or they correct it for you with a patch on your own computer.

In addition, you don't have to send us a mistake-report-form. Our support and maintenance staff is as close to you as your telephone and your computer.

PROFIT MOTIVES

DBMS software is not cheap. You can pay from $5,000 to over $100,000 and buy a wide range of capability and functionality, so careful shopping is necessary. System 1022, with all its separately-priced modules, costs only $54,000—and substantially less for the smaller DEC-2020 computer. For this price, you receive a perpetual license with one year of our maintenance and update service. Convenient lease and rental terms are available, as well as generous discounts for tax-exempt institutions.

Our price is only a fraction of what it costs us to develop and enhance System 1022. And it's only a fraction of what it would cost you to develop and support comparable software yourself.

But best of all, you can make a profit from System 1022. You might do what the time-sharing director of a large insurance company did. With System 1022, he increased his staff's efficiency by "5 to 10 times over conventional methods of application development." Or the head of the management-consulting division of an engineering company. His division "can now handle far more projects with fewer people." Or because of System 1022, you might not need to hire two more good programmers—or one more bad one—this year.

Each of our customers—large and small—has a unique System 1022 profit story to tell. One of them is probably in a computing environment just like yours.

STANDARDS

System 1022 is now the information management standard for large DEC computers. Hundreds of organizations—in the U.S. and around the world—use it on DECsystem-10 and DECSYSTEM-20 computers. No other DEC-10/20 DBMS is as widely used as System 1022.

Naturally, such a large user base gives you many benefits. It ensures that we'll be around to support and enhance System 1022 long after DEC discontinues its 36-bit computer line. And it provides plenty of System 1022 application ideas and experience for you to tap, either through our user newsletter The Audit Trail or by direct contact with users at our annual Users Conferences. In addition, other software vendors now interface their products to System 1022. This gives you a variety of complementary and compatible software to choose from as your needs grow.

PRESIDENT ALSO INVOLVED

Our president is an honest man. When he decided to market System 1022 back in 1976, he knew it was not a relational DBMS. So he told his salesmen not to call it relational.

Despite our relational disclaimers over the years, our users have discovered that System 1022 effectively helps them manage their information. They use and rely on its many relational features so much that they believe System 1022 is a relational DBMS, even though it strictly isn't.

Our president and his salesmen are still honest. Furthermore, they all have years of hands-on experience with systems programming and application development, so they don't have to confuse you with sales jargon or high-pressure sales techniques. You should feel free to call on them for help. After all, as any programmer will confirm, it's almost impossible for one programmer to tell a lie to another and get away with it.

THE ULTIMATE PROOF

The best proof of System 1022's value to you is how it works at your own site, with your own information and users. That's why we offer you a free 60-day trial and on-site technical seminar.

During the free seminar, you learn about the System 1022 features that we don't have the space to discuss here. You can ask some tough questions and receive knowledgeable, accurate answers.

During your free trial period, you can verify how easy System 1022 is to install. Read our clear, literate documentation and test our hot-line support service. Compare and benchmark System 1022 against other systems—relational or not—that cost half as much or twice as much. Take some of your largest data files and let System 1022 prove how quickly and easily you can build applications around them. And watch your programmers—and your end-users—learn to use System 1022 productively in a matter of hours, without having to attend special training classes. You'll be very pleasantly surprised.

If you have a DEC-20 or DEC-10 computer, we urge you to call Lynda Jones at the number below to arrange your free trial and on-site seminar. Call your DEC salesman, too. If he doesn't already know about System 1022, he should.

Some of you may think that our claims and our offer sound too good to be true. Or you are already using other software that you bought or developed without investigating System 1022 in depth. Some of our customers have been in exactly those predicaments, but they called us and now have some of the most successful computer shops around.

So don't delay. Enjoy the productivity improvement and user satisfaction that System 1022 provides. Give us a call today with no obligation.

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By James M. Tharrington

A MANAGER'S GUIDE TO MEASURING PROGRAMMER PRODUCTIVITY

In the last several years, the average data processing department budget's concentration has shifted: more than 50% of the budget is now being allocated to personnel costs.

Whereas hardware and software once accounted for the bulk of a data processing department's costs, the cost of maintaining a staff is now beginning to overshadow any other expense. Because of the increasing marketplace demand for programming and systems personnel, companies find themselves engaged in near "bidding wars" for qualified employees. Salaries in these areas are rising quickly, further contributing to the budgetary shift and giving management cause to worry about what the coming decade will bring in terms of personnel costs.

This growth in personnel costs is forcing data processing management to seek ways to measure and improve programmer productivity. When salaries are high and competition for good people fierce, managers necessarily begin to consider how they can reap the greatest benefit from each employee hour.

In the course of these attempts to improve productivity, such methods as structured programming techniques, structured walk-throughs and use of programmer teams, to name a few, have been tried, and some have achieved a measure of acceptance and success.

How Productivity Improvement Methods Work

Structured programming and structured walk-throughs represent technologies or methodologies that help standardize program solution or the evaluation of solution design. The concept behind programmer teams is to bring together specialists in technology — from areas such as communications, for example — and assemble them as teams for the purpose of solving a particular problem.

Despite the degree of acceptance that these methods have gained, there remain some problems. These productivity improvement methods are usually most successful in large, and thus highly structured, data processing environments — typically, departments with more than 50 systems and programming personnel. However, the majority of today's data processing departments have fewer people (typically five to eight programming and systems people).

Measuring Programmer Productivity

In these small departments, some of the productivity techniques mentioned above may not be effective since the necessary resources are usually available only in the larger departments because of the dollars or skills of personnel involved. Ironically, the departments that may most need to optimize the productivity of their people — the smaller departments — are often least able to take full advantage of the accepted methods of productivity improvement.

However, as we shall discuss later, even small departments can take steps toward greater productivity.

New Approaches

One of the keys to greater productivity lies in managers' being open to new approaches to the assignment of work. To succeed in this effort, managers should become aware of the difference between mere division of work and careful analysis of the work to be done, including the skills or aptitude of the staff available to do it.

An analogy to the area of industrial engineering will illustrate this contrast and help highlight the different perspectives on problem solving

In order to identify greater efficiencies that may be realized, industrial engineers study an activity and break it into its component parts. No activity, however uncomplicated it may appear to the casual observer, seems entirely simple after it has been analyzed by the industrial engineer's process.

For example, the supermarket cashier's function of checking out a grocery order does not seem to be a complex process to most people. However, to the industrial engineer, the checkout of a single item would be composed of the following elements:

1. Picking up the can or package.
2. Rotating it to find the price.
3. Entering the price into the cash register through the keyboard.
4. Turning around with the can or package in hand.
5. Placing the can or package either at the back of the checkout counter or into a bag.

Thus, what to the average person appears to be one simple operation is to the industrial engineer a series of five distinct steps. Having isolated these five elements, the industrial engineer is better equipped than the average person to discover how the process may be streamlined and improved.

The most significant aspect of this analogy is that the industrial engineer first spends the time necessary to understand the nature of the activity in detail and in its entirety.

Cue for DPers

Data processing departments could take their cue from industrial engineers when assigning and scheduling work. Too often, data processing managers resemble nonengineers viewing supermarket checkout in the above analogy.

The writing of a program, or more precisely the selection of a programmer to write a program, is typically viewed as an uncomplicated and, therefore, straightforward process. More often than not, the assignment of a programmer to write a program is made with minimal consideration of how the programmer's abilities or skills will fit the problems or program needs, especially in data processing environments with modest staffs.

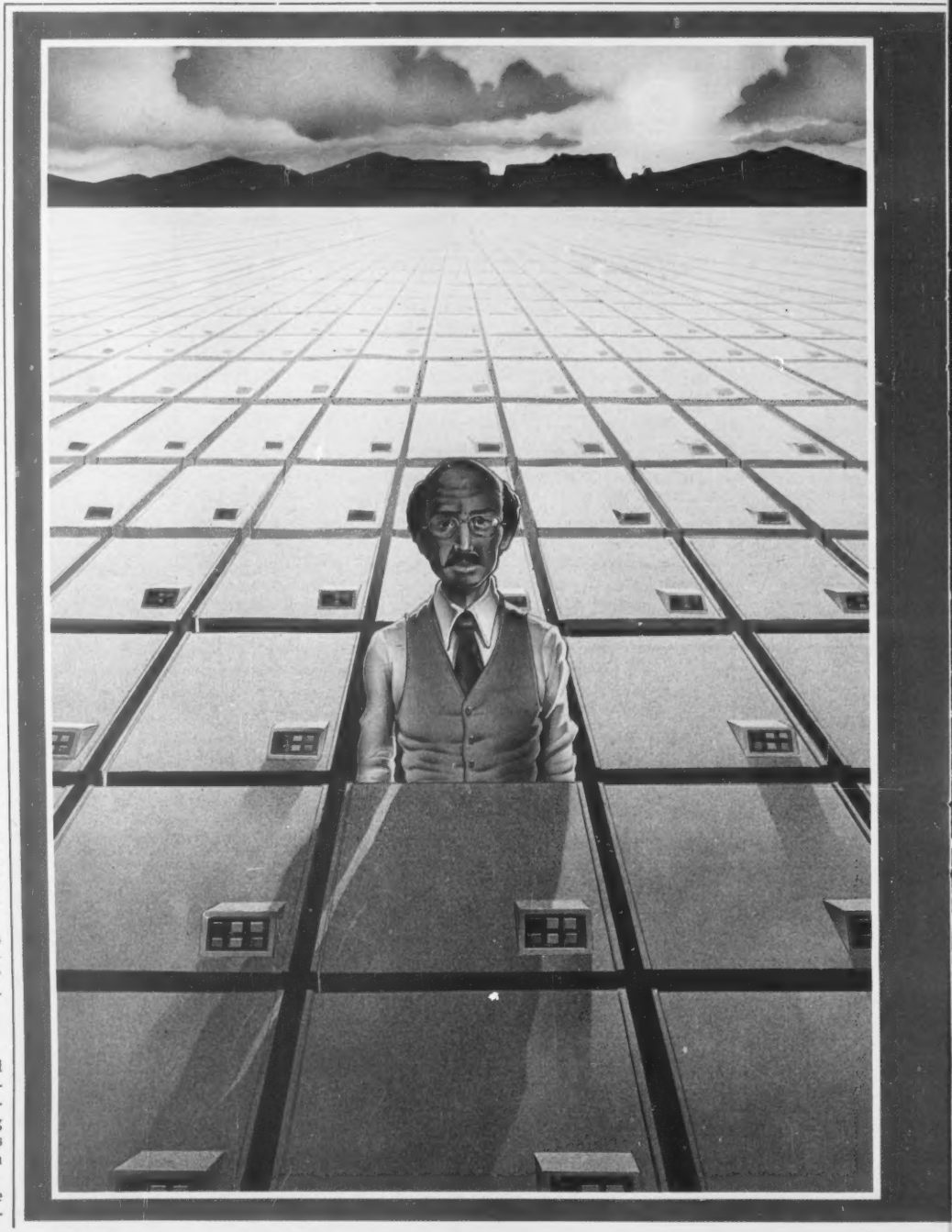
Basic Approach

However, even in larger departments, this basic approach will be followed: One person is assigned to the program, perhaps somewhat arbitrarily or upon a basis of availability.

The programmer's responsibilities can be broken down into the following components to facilitate intelligent assignment of work:

- Designing of the programming logic, which will include flowcharting, program description, development of decision tables and the ongoing corrections or changes to any of these that may be necessitated by program or system design changes.
- Coding and developing test data, which includes coding the actual program, developing test data, preparing a run book and making the necessary corrections or changes to the run book as changes and corrections are made to the program.
- Testing and debugging, which includes assembling or compiling the program, desk-checking the results, processing the program with test data and analyzing the test data runs.
- Preparing final documentation, which includes the continuous updating of all existing documentation that may have been previously prepared.

In most larger and, in theory, more



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"The human element may now be . . . the most valuable – and costly – element of all"

highly structured departments, levels of skills are more clearly identified — not unlike the industrial engineer's perspective of supermarket checkout — and quantified and technical expertise is represented by personnel assigned to known specialties.

Therefore, a number of people utilizing some of the productivity techniques previously mentioned may be involved in writing the same program, each contributing a specific strength or skill to the process.

Of course, all of these productivity techniques have an overhead attached to them.

A staff structure of some sort is required to maintain, control and monitor the utilization of these methods. Obviously, many data processing environments cannot afford this luxury of staff and overhead.

Overhead and Size

Thus, effective utilization of some of these productivity improvement techniques really depends upon whether the data processing department can afford and manage the associated overhead. Even the smaller department, however, can take better advantage of the personnel resources it does have.

In many respects, the smaller data processing department has a sizable advantage over its larger brother. The smaller the size, the closer the relationship between members of the department and the more intimate the knowledge of one another's abilities.

Although the smaller department may not be able to afford the productivity tools some larger departments have, it does have the advantage of more frequent interaction at a much more intense level, which results in a better understanding of the skills of the members of that department. Thus, some small departments may be far better equipped to handle the matching of skills to problem needs.

Estimating Techniques

For those who are looking for a systematic, basically mathematical approach to improving productivity, there are a number of techniques for estimating the amount of programming time and other resources required to write a program or system file.

Most of these methods involve segmenting the program or system into a series of small elements such as file structures, file accessing techniques, processing algorithms and processing interrelationships, if any, with other systems. All these elements are then assigned weights or values. Programming staff members who would be assigned to these particular elements are also rated according to levels of skill.

These rating factors for both program complexity and programming staff capabilities are then assigned time values and the resultant arithmetic extension is an estimate of the amount of time required to complete the program or system.

Despite the level of sophistication some may achieve, these estimating techniques still rely on the same basic approach taken by the industrial engineer — the process must be studied and broken down into its significant elements.

The Human Element

These estimating techniques, however, are cold and impersonal. In my experience, the problem with strictly quantifying characteristics and capabilities is that the human element is seldom considered. For that matter, it really cannot be considered under this system because it cannot be quantified.

And any manager who neglects to consider the human element is not taking full advantage of his most valuable resources. In fact, as noted at the beginning of this article, the human element may now be considered the most valuable — and costly — element of all.

In other words, the best way to know what your people can do, and thus to estimate their capabilities, is to get to know their ability and performance under a number of different circumstances. In this way, you should be able to come up with estimates that are equal to, and in the majority of cases better than, those derived from the techniques described above. In addition, there is no known technique that can match the experience of senior data processing personnel in providing estimates for a project.

Test Case

In the process of testing this concept, we analyzed a system development project at a large retailing concern using one of the measurement tools described above.

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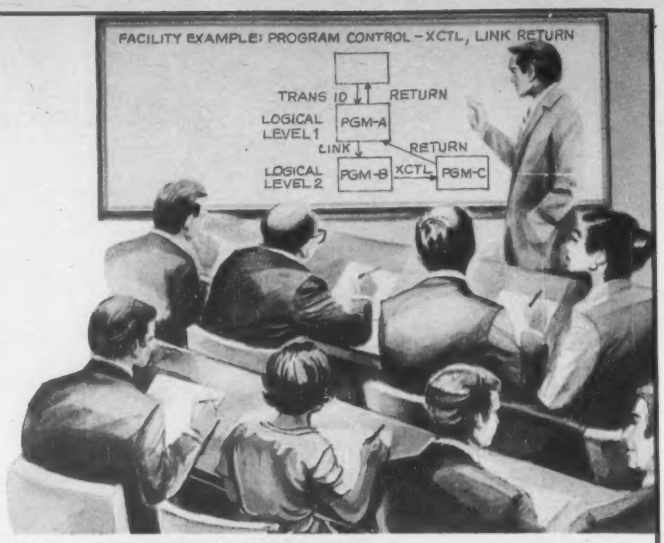

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the employees and the problem, we attempted to use the tool to come up with an estimate of the time required to execute this particular problem solution.

While we were doing this, we made a request of the programming manager, who believed in these types of measurement tools but felt the element of human judgment was crucial to the proper evaluation and possible adjustment of the tools' estimate.

We asked this person to evaluate his staff, the personnel he would assign to the problem, and to come up with an estimate of what programming efforts would be needed to complete this assignment.

The programming manager and I were comparable in terms of experience, skills and education. However, when the estimates were compared with the actual performance eight months later, the difference between the two was astounding.

The programming manager had estimated the project within an error of 8%, while we, using the estimating tool, had arrived at an estimate that was off by 18%.

The Difference

His advantage, of course, was his knowledge of his staff. The difference proved that although tools may expedite the development of an estimate, only the knowledge of a seasoned professional in contact with his people on a day-to-day basis can provide the fine tuning necessary to make a really meaningful estimate.

In recent years, users have been clamoring for the development of facilities to aid programmers in coding, thereby increasing their productivity. Hardware and software vendors have come up with various productivity tools, such as data base management systems (DBMS), application generators and on-line programming facilities.

Each of these tools can aid in particular areas of the program development cycle, and their use does help to lower the amount of time spent by the programmer in that particular area of the cycle.

DBMS, for example, allows the centralized construction and maintenance of all file information for the programmer. However, the programmer must approach the data base administrator and identify the data needs for the program. The data base administrator will provide the data base segment for use within the program.

On-line programming facilities allow programmers to avoid the problems so commonly associated with batch job development. It allows them to work at their own pace utilizing a CRT, to write program code, test it and actually structure test files and data for program testing.

Using Users

Application generators also allow people with lower levels of skills, such as actual end users or less experienced programmers, to work on the development of applications. This is extremely important because it further reduces the inaccuracies commonly associated with the end-user/programmer analyst interface that is traditionally required.

With the end users doing more of their own development effort, the traditional errors that can creep into systems or programs are usually minimized.

These tools have their place in the data processing department that can afford them. They do, however, have both a dollar cost and hardware overhead associat-

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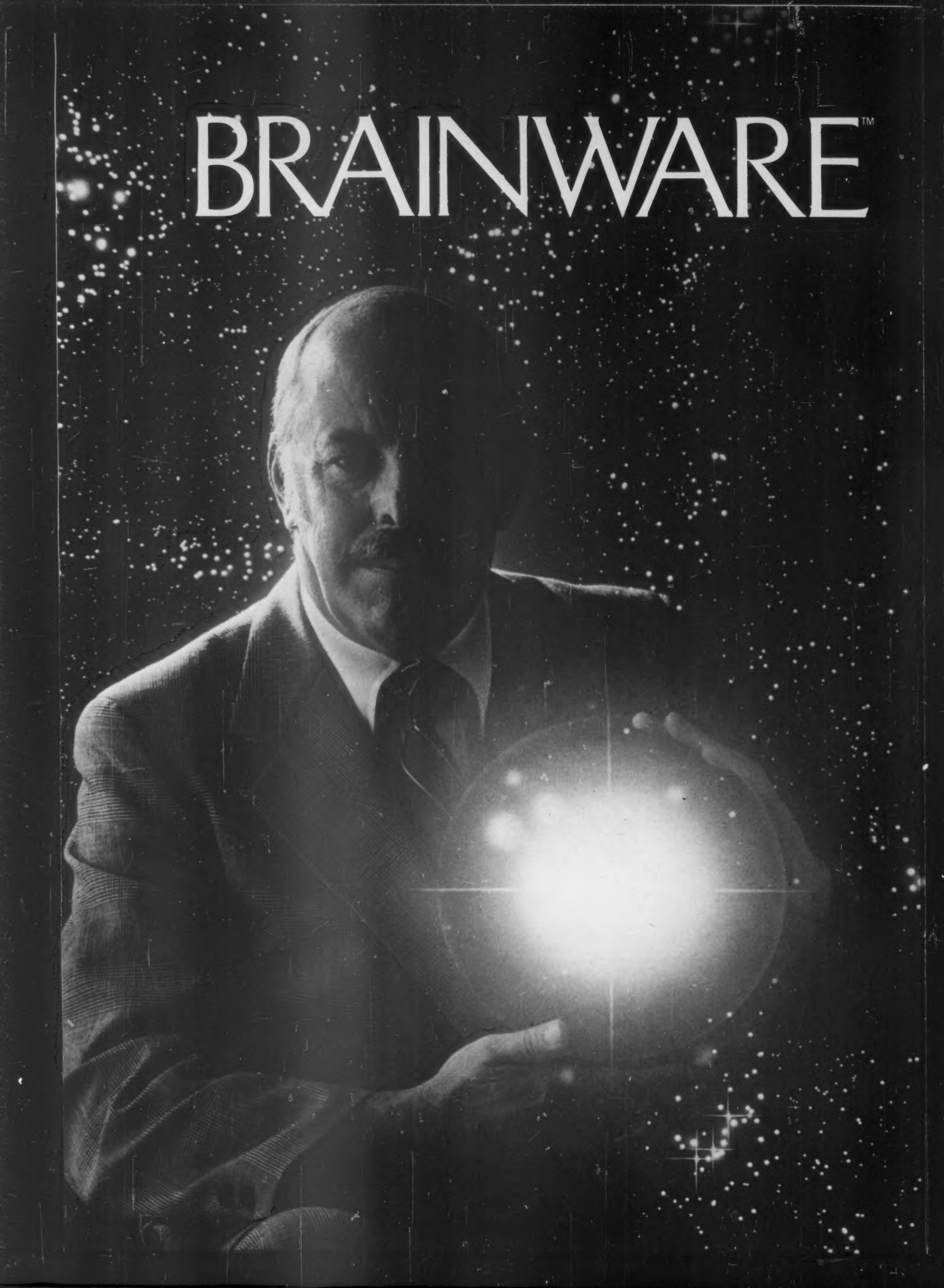

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Measuring Programmer Productivity

ed with their use.

Thus, management's first priority in using these tools must be to ensure that they are used effectively and that they are not intended to replace basic data processing skills. They cannot take the place of traditional skills such as flowcharting, algorithms development or analysis.

The programmer should utilize them only after the problem to be solved is thoroughly analyzed and understood.

Programmers traditionally spend their time as follows:

- Designing and analyzing the problem to be solved — 40%.
- Coding the solution — 20%.
- Testing and bench checking the program — 30%.
- Documentation — 10%.

Experience has shown the key to solving any problem lies in first understanding its complexity. Thus, every day spent on an analysis and design results in days (three to five) saved in coding, testing and checkout.

In fact, if one includes flowcharting or the development of decision matrices, one can further reduce the time spent on testing and bench checking a program to probably around 20%. More time spent in planning, analysis and evaluation of the problem, then, means less time spent in coding the solution, testing and bench checking programs.

Jumping Gun

There is a tendency to rush into writing the program code before really knowing what the problem is all about, a tendency that generally results from the user's pressure to get something done and from the programmer's desire to prove his worth by showing some results.

This tendency to jump the gun and write code immediately will result in unnecessary lines of code that will undoubtedly come back to haunt you later, when substantial revisions are required or the program has to be done a second time to correct earlier unrecognized deficiencies.

Clearly, then, one of the best ways for any department — large or small — to improve productivity is to make sure that adequate planning precedes the writing of programs. Fancy technique cannot replace solid skills and careful analysis.

Thus, in spite of the growing number of aids and techniques for the programmer, the improvement of productivity or the measurement of programmer productivity still has one basic requirement: effective day-to-day management of these programming resources.

If the tools are incorrectly used or the measurement of the programmer is impersonal and oriented toward quantity, not quality, these techniques will not be effective. Effective management of programming personnel is the key to improving programmer productivity.

Data processing managers usually achieve their positions as a result of performance, skills and experience. These three key factors, *in conjunction with* the tools, aids and measurement techniques described earlier, are the keys to improving programmer productivity.

Even in the management of programmers, it is still the human element that is most crucial in the success of measuring and improving productivity.

Tharrington is a principal and partner at Case and Company, Inc., a management consulting firm headquartered in Stamford, Conn. ◆

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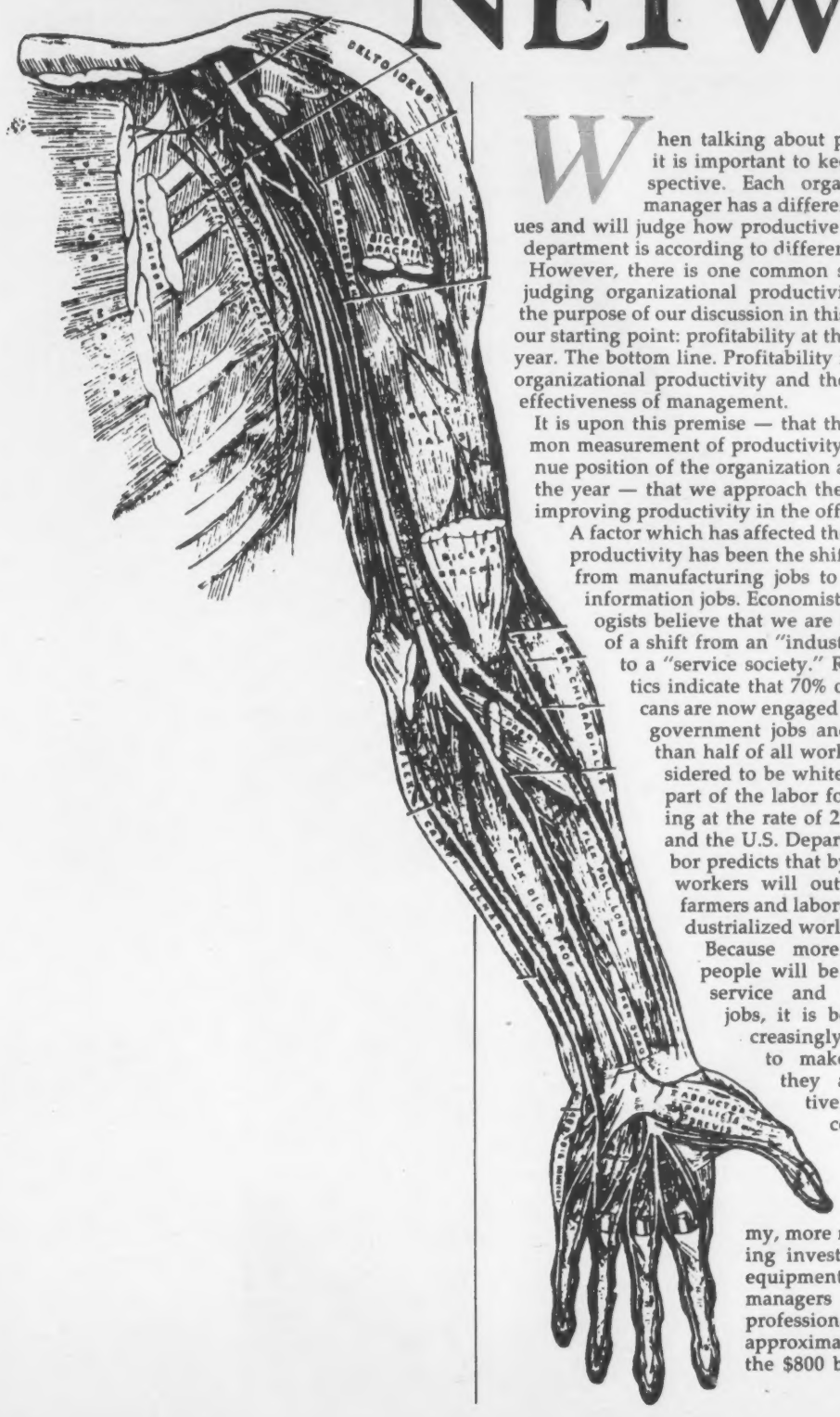
By Harry Viens

THE HUMAN NETWORK

What is office productivity? Is it word and data processing equipment, bits and bytes, page counts and printouts? The author sees three critical components of the office: People, Procedures and Equipment. He is concerned with the people who work in offices, the kind of work they do and how it gets done.



When talking about productivity, it is important to keep it in perspective. Each organization or manager has a different set of values and will judge how productive a person or department is according to different standards. However, there is one common standard for judging organizational productivity and, for the purpose of our discussion in this article, it is our starting point: profitability at the end of the year. The bottom line. Profitability reflects total organizational productivity and the leadership effectiveness of management.

It is upon this premise — that the only common measurement of productivity is the revenue position of the organization at the end of the year — that we approach the problem of improving productivity in the office.

A factor which has affected the U.S. rate of productivity has been the shift of workers from manufacturing jobs to service and information jobs. Economists and sociologists believe that we are in the midst of a shift from an "industrial society" to a "service society." Recent statistics indicate that 70% of all Americans are now engaged in service or government jobs and that more than half of all workers are considered to be white-collar. This part of the labor force is growing at the rate of 2% each year, and the U.S. Department of Labor predicts that by 1990 office workers will outnumber the farmers and laborers of the industrialized world.

Because more and more people will be engaged in service and information jobs, it is becoming increasingly important to make sure that they are productive. As we become more of a service and information economy, more money is being invested in office equipment. While managers and other professionals receive approximately 60% of the $800 billion spent

The Human Network

spent annually on salaries and benefits for office-based white-collar employees, most of the time and money spent in the office has been to make the clerical staff more efficient. A Booz Allen & Hamilton survey recently predicted that by the year 1990, white-collar operations will exceed $1.5 trillion annually.

In addition, a recent survey conducted by Louis Harris and Associates of a cross-section of 1,004 office workers in the U.S. indicated that they believe they could do more work in a day if the conditions and circumstances they work under were changed.

No 'Quick-Fix'

In view of these statistics, it becomes evident that any effort to increase the rate of productivity in America cannot ignore the office environment. Increasing productivity, however, whether in the office or in a factory, is not a simple task. It cannot be accomplished by the application of a "quick-fix" solution such as simply buying expensive new equipment or firing workers and demanding more from those who remain.

Frequently, the solutions which are offered in hopes of improving productivity focus on only one of these areas. Most common is the assumption that new, advanced office equipment will automatically solve the whole problem. Technology, however, while playing a potentially major role in productivity improvement programs, is not the whole answer.

Above all, it is important to remember that the office is a human network, where people — with their different habits, attitudes, abilities and needs — are the central element in the office environment. Office solutions that bypass people and the way they perform their work will clearly not be effective.

So, while businesses are making profits, there is always room to improve, to capture more of the market and become more productive as a total organization.

We believe a better corporate understanding of the factors that contribute to making office workers more effective and efficient would greatly enhance efforts to improve an organization's overall productivity.

What are these productivity factors?

We suggest that any effort to improve the organizational contribution of office workers be assessed in terms of people, procedures and equipment. There is no mystery to this approach. It is a very commonsense way of looking at what often seems to be a confusing office environment. But successfully improving and integrating these three elements of the modern office cannot be done without hard work and patience.

People Factor

People are the life-blood of organizations and if people aren't productive, their organizations aren't productive. From secretaries to top management, employees must be motivated to do their jobs the best they can for success to be possible.

It can be said, of course, that this is obvious — that management learns how to motivate and manage people through on-the-job experience and business education. Certainly, that should be the case, but how many times has a new way of doing things failed to work because the people who have to make it work were not involved in, or supportive of, the change? How many times have managers gone through a lot of

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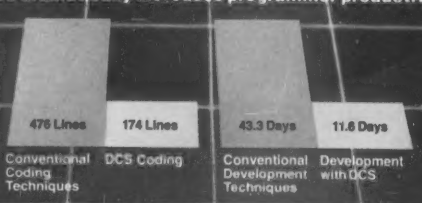

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work to make a procedural or system change, and then found that the problem all along was really a "people" problem?

Without question, the interpersonal and leadership skills of managers play an important role in influencing the productivity of subordinates. And it is frequently overlooked that such skills can stimulate high levels of effectiveness and efficiency in the office, even without the aid of new procedures or equipment.

Research into managerial work habits indicates that management is not really the science some think it is, but rather an art. And the art must be further developed and refined with regard to leadership and motivation if office worker effectiveness and efficiency are to improve.

The office has traditionally been treated as if it were a factory, where centralization and assembly-line-type procedures could be applied to increase worker productivity. Computerization of manual office functions has often reaped savings, but the impact on worker effectiveness has more often than not stopped there. Middle managers have frequently resisted the centralized mainframe computer, viewing it as unresponsive, overly structured and isolated from their daily decision-making environment.

Cost savings and quality improvements in the early days of centralized word processing were also lower than anticipated. Savings were sought through more efficient typing, but it turned out that clerical staffs do not spend most of their time typing. Quality levels were often inconsistent largely because quality was still directly related to the individuals who compiled, wrote and typed the material.

Similarly, many managers rely excessively on written and more structured communications, ignoring informal lines of communications with subordinates. It is very important that subordinates have verbal and lateral contact with their managers; it satisfies their need to participate and allows the manager to get honest reactions and feedback that would not come through in a one-way memorandum. Recent surveys indicate that workers believe they could be more productive if they were to receive more encouragement from managers and supervisors.

In general, it is a good policy to design new office systems and procedures around those that have to make them work — be they managers or support staff — rather than unilaterally force changes and be sorry later.

Make more environments "good environments." In the survey conducted by Louis Harris and Associates, Inc., it was found that the majority of office workers feel there is a strong correlation between the quality of work environments and the quality of job performance.

For instance, 71% of office workers felt that improvements in air temperature and circulation would help make them more productive. A majority (67%) also cited a need for quieter offices to increase concentration. And 54% thought better or more office equipment could contribute to improved work output.

The office is a dynamic place where people often work on several projects at once and are frequently interrupted by the phone, their superiors, or other workers who need information. It is a place where information must be easily accessible and readily understandable. Of-

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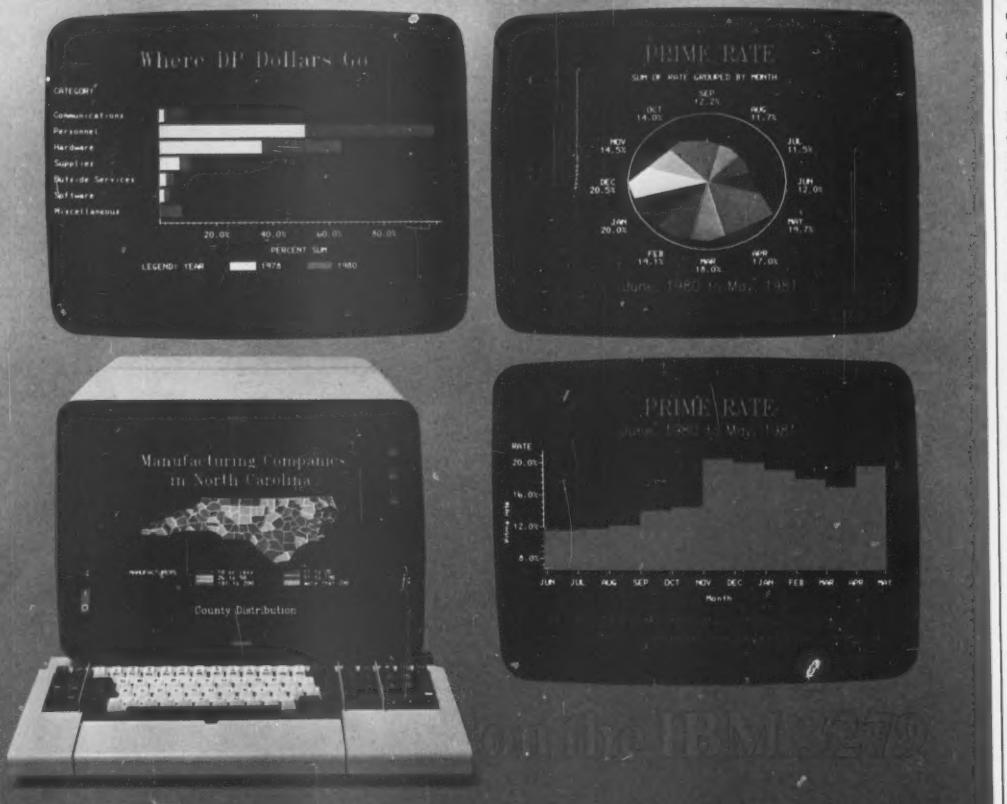

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"There are as many ways to design offices as there are organizations and individuals to design them for."

fice work is a mixture of repetitive, standardized, structured activities and the often spontaneous unstructured activities which characterize the information flow between higher level employees.

Studies show that managers work at an unrelenting pace; their activities are characterized by brevity, variety and discontinuity; they are strongly oriented to action and dislike reflective activities.[1] Managers strongly prefer the verbal media of telephone calls and meetings to any highly regulated hierarchical decision-making system. Also known from previous research is that the vast majority of mail a manager receives is of no immediate or specific use in making important decisions.

Certain human characteristics must be carefully considered when planning the office environment. For example, people have a limited ability to recall information. They need to converse and interact with others. They need a certain amount of privacy. They need to move around to retain their vitality. They need positive feedback and recognition And, they like attention. The famous Hawthorne experiments taught us some time ago that attention is in itself a motivator.[2]

So what does this tell us about office design? Most importantly, it tells us that the office environment does have an influence on job performance in terms of personal comfort, work flow and the employee's capacity to assimilate and access information.

There are many examples of the negative effects of "bad" environments and bad office design. The important thing to remember, however, is that there are as many ways to design offices as there are organizations and individuals to design them for. There are no absolute right or wrong ways to do it, but there are a few proven successful practices:

1. Involve those who will be using the space in the planning stage.

2. Design office space only after you understand the needs and work characteristics of those who will be using the space. In other words, know their procedures and how they use various office equipment.

3. Whenever possible, allow individuals the freedom to make adjustments to their office space. Permit the individual as much creative expression as possible.

Make more jobs "good" jobs. In the late 1970s, the term "quality of work life" gained wide currency in the field of industrial relations. A fuzzy, broad, inadequate term, it sufficiently confused enough people to stimulate numerous authors to define it and detail how it could be achieved in the work place. Everyone — authors, rank-and-file workers and managers — ultimately had their own definitions.

Thanks to the American Center For The Qualify Of Work Life, the meaning of the term has since become more focused and better defined.

Primary Problem

One of the primary problems with the term is that "quality of work life" isn't a single, specific notion. Rather, it subsumes a whole collection of terms and notions, all of which really belong under the "quality of work life" umbrella:

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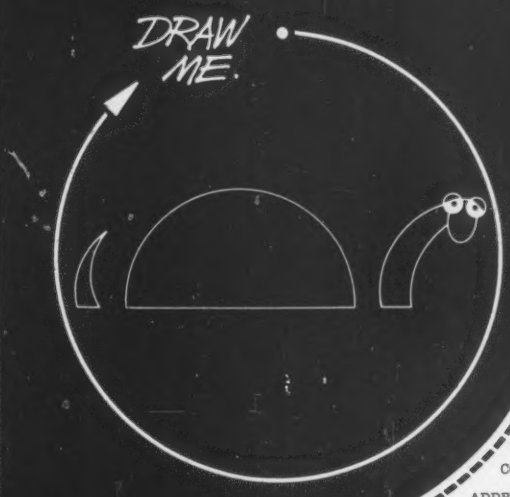

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The Human Network

- Labor-management cooperation.
- Working together:
  Worker involvement.
  Worker participation.
- Cooperative work structures[3].

The "quality of work life" concept suggests that human energy can be more easily released and applied by adapting traditional organizational management methods to the needs and values of the 20th-century worker. This adaptation is particularly important in light of the changing nature of the world work force — from a heavily production-oriented labor force to a service- or information-based labor force.

We should try to make more jobs "good" jobs. A substantial portion of office jobs are currently characterized by low pay, little training or advancement, little job security, authoritarian supervision and arbitrary discipline.[4]

In the production environment, the result of having too many jobs with these "bad" characteristics was absenteeism, rapid turnover and, most important, "don't-give-a-damn-ism." Employee commitment to the product, the company's competitive position and the quality of their own work all deteriorated.

As with the office design, there is no universal solution. Each organization must customize its solutions to its own unique character. This will happen naturally if people participate in the problem-solving process, with the support of top management. By recognizing people as the most important variable in improving organizational effectiveness, the quality of work life approach could do much to enhance organizational productivity.

What Is A Procedure? Normally, we tend to think of a procedure as a predefined sequence of activities required to complete a particular task or objective. From this perspective, procedures can be viewed as a means of establishing control over a process, thereby ensuring consistency in timeliness and quality of response to a given problem or set of conditions. Procedures serve as control mechanisms in an organizational structure.

Procedures can also be viewed as a way of minimizing the time people need to complete a task. Or they can be seen as the result of the natural human tendency to make work easier by establishing a process that can be routinely followed.

Regardless of how one perceives office procedures, there is an underlying reason for their existence. Procedures, after all is said and done, are really efforts to control the use of knowledge within an organization — knowledge being defined as useful information (financial reports, sales orders, credit authorizations, invoices, memos, telephone listings and so on) that has been captured within the organization, in one form or another. Thus, we can look at the office as a sort of clearinghouse for knowledge, and procedures as the vehicle we use to help us utilize this knowledge and achieve our organizational objectives.

Procedures can be loosely or strictly enforced. They can apply to long-term projects or everyday activities. They affect everything from the filing of information to the processing of sales orders to the dictation of memos. They can evolve around computers, or have nothing to do with computers.

People and procedures are inseparable. Efforts to improve productivity through improvements in procedures and work methods must address total systems — not just individual effectiveness or efficiency. Procedures relate to the total process. For this reason, it is important to understand corporate or departmental objectives before implementing or changing procedures. It is important to ask: "What is it we are really trying to accomplish?" Is it more work, faster work, higher quality work, better customer service, cost cutting, elimination of red tape, more competitiveness or better management?

Once the objective is understood, it will be easier to design appropriate procedures and work patterns. A manager can then go to his staff or subordinates and say: "This is what we'd like to accomplish. What do you think? It is realistic? Can we do it? How would you do it? How do you see yourself fitting in?"

A natural conflict often exists between people and procedures, as is the case when organizations employ rigid control systems. These systems help organizations minimize redundancies and inefficiences, allow for careful monitoring of important aspects of organizational performance (for instance, productivity, financial status and staffing levels) and provide a concrete basis for taking corrective action. However, such control systems also tend to limit the

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"With the current burgeoning shift from the factory to the office has come a perceptible shift in computer applications."

complexity and challenge of jobs. In an attempt to pinpoint accountability, these systems often specify in considerable detail exactly who is to do which tasks — thereby restricting the autonomy in jobs.[5]

Successful productivity improvement programs in such environments require the use of tailor-made strategies. Take the following strategy used by a middle manager in a large bank who wanted to make changes in her department. In this case, virtually all organizational systems were thrown into disarray as plans were being laid for introducing new data processing equipment into the department and, as a by-product, reducing staff size by almost one third. The manager was responsible for redesigning the work flow around the new equipment and she took the opportunity to create a motivationally sound set of jobs.

She began by conducting a diagnosis of existing jobs, to identify existing motivational strengths and weaknesses. She then persuaded her staff to generate fresh ideas on how to enhance the motivating potential of the new jobs. The new ideas were then tried out by some of the people who would fill the redesigned jobs and were further revised, based on their reactions and suggestions.

Finally, when the basic work flow and new job descriptions were almost ready, she examined each operating system in the unit and made changes where necessary to ensure that those systems would fully support the work and the employees. The payoff for all of her efforts was a relatively smooth implementation of the new system, with minimum employee dissatisfaction.[6]

What differentiates good procedures from bad procedures? As with measuring productivity, choosing the best procedure for a given work situation is largely a subjective judgment. It is also what managers get paid for. There are no hard and fast rules and the needs of no two organizations are the same.

There are, however, some characteristics of good procedures and productive management attitudes towards procedures in the office:

1. Good procedures not only contribute to the achievement of corporate or departmental objectives, but they also allow those involved to take pride in and identify with the completed product or service.
2. Good procedures allow those completing the work as much autonomy as possible in scheduling the work and carrying it out.
3. Good procedures incorporate feedback mechanisms to provide office workers direct, useful information on the effectiveness of their performance.
4. Good procedures assign to people what they do best and to machines what they do best. Since organizations are increasingly installing more and more computers or computer-based word processors, this is a critical point.
5. Good procedures help meet the needs of the individual, as well as those of the organization.

Similarly, good management attitudes toward procedures are characterized by:

1. An openness to procedural changes.
2. A commitment to looking for new ways to improve a process or system.
3. An active encouragement of workers' offering their perspectives.
4. An awareness of the total system and desired objectives.
5. A willingness to experiment, to tinker with the "system" by trying new ideas on a test basis.

With the current burgeoning shift from an industrial to a service economy, from the factory to the office, has come a perceptible shift in computer applications. From its traditional use as a control and number-crunching device — typically centralized and in the realm of the programmer, systems analyst and data processing specialist — the computer is increasingly being applied as a decentralized tool for helping office workers at all levels do their jobs. The focus is moving, quite naturally, from the centralized computer service approach of the past, to the decentralized "office automation" approach of the future.

What is office automation?

It is the process of optimizing, at any given time, the cost-effectiveness ratio of human vs. technological resources in the creation and management of knowledge in the office.

Implicit in this definition are several important ideas, all of which center on the People, Procedures, Equipment concept proposed here for improving productity in the office.

1. Office automation is a process, not a product; it is an attitude as much as it is an identifiable set of hardware and software. It is a com-

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The Human Network

mitment to considering new ways of doing work.

2. Office automation is an ongoing, dynamic activity. As people and organizations change over time, so too must office automation systems.

3. Office automation requires a careful consideration of the relative cost-effectiveness of human resources and machines. Basically, this means letting machines do what machines do best, while letting people do what people do best.

4. The objective of office automation is to improve the management of knowledge — information which has predictive or historical value — in the office.

Of these ideas, the one that relates most directly to equipment is the relative cost-effectiveness of applying machines or people to particular tasks. People are best at identifying tasks, evaluating the results and making decisions based on their experience. Machines, on the other hand, are much better equipped to perform repetitive, routine, tedious tasks — the kinds of tasks people should not only not do, but typically don't want to do. When computers and people are optimally utilized, then, the result is not only improved cost-effectiveness, but an enhanced quality of work life for the employee.

The primary function of computers in the automated office is to condense the communication and decision-making process so that information can be acted on almost immediately upon being "captured" within the organization. When word and data processing leverage or replace human effort, they shorten the communications and decision-making cycle.

Can an investment in equipment produce direct cost savings and a return on investment?

Yes, it can. Typically, the savings take the form of displacing outside services, freeing up space and freeing up human resources through a reduction in manual effort. Equally important are the indirect benefits of such investments, which may range from improved customer service to more effective management decision-making to higher quality reports.

The possible cost of not investing in office automation should also be taken into account. These costs could realistically be quite high in terms of not having needed decision-making information available.

Will equipment disrupt or contribute to the organization?

The answer to this question depends on how well each organization understands the sensitivities of its people, the objectives of the organization and the limitations and uses of equipment. If equipment is forced on people, if it is not introduced with care, if it is perceived as a threat rather than an asset, if it does indeed make a job "bad," it will surely be disruptive.

People are the key to getting equipment installed and operating at optimal effectiveness. Equipment should be introduced and used to help individuals do their jobs better, not to overly simplify and diminish the meaningfulness of their jobs.

As managers who make decisions that impact many people, we should refine our management skills. As clerical workers, we should seek out more responsibility and show that we deserve it. We should consider it our obligation to tell the boss: "This might work better if we try it this way." And as planners, we should be concerned about the role of people in the office, about what challenges and motivates them and how technology will impact them.

To the extent that we are successful in creatively addressing our concerns and responsibilities, tomorrow's office will be a better, more productive, more rewarding place to work.

Notes:

[1] *Harry Mintzberg, "The Manager's Job: Folklore and Fact," Harvard Business Review, July-Aug. 1975, pp. 49-61.*

[2] *Robert Propst, "The Office: A Facility Based On Change," Herman Miller, Inc., 1968.*

[3] *Quality of Work Life; "What's In A Name?" General Motors Corporation, 1978, pp. 7-8.*

[4] *James Driscoll, "People and the Automated Office," Datamation, Nov. 1979, pp. 106-112.*

[5] *J. Richard Hackman, Mary Dean Lee, "Redesigning Work: A Strategy For Change," Work in America Institute Studies in Productivity, 1979, p.9.*

[6] *Ibid, p.14.*

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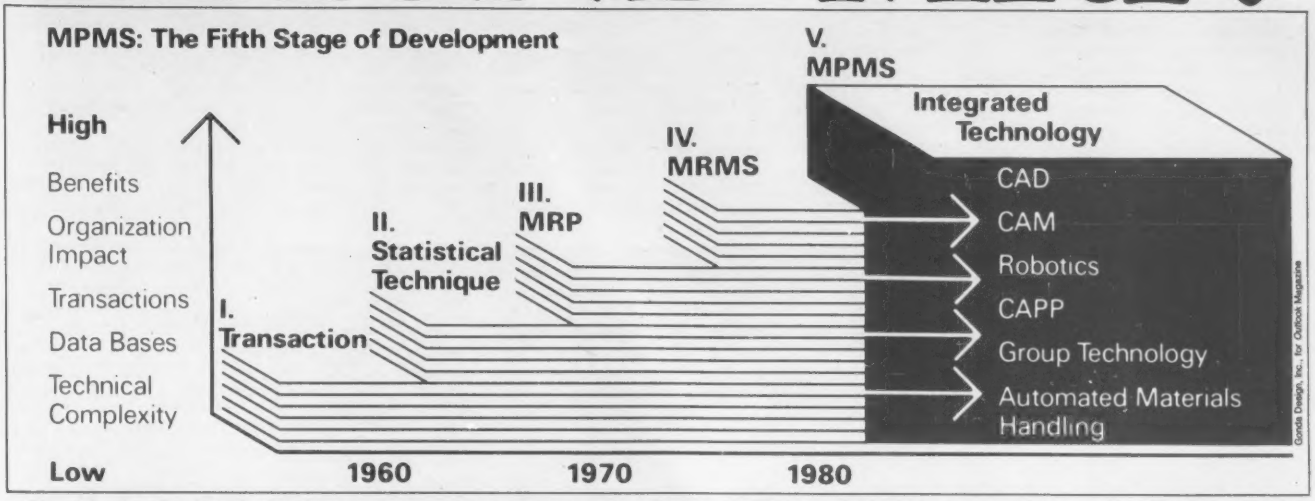

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The firms investigated — 1,480 in all — included 550 in Europe, 550 in Japan and 380 in the U.S. and spanned over 15 industry subgroups. Annual revenues of the firms ranged from $50 million to several billion dollars, most were multinational or had extensive export operations, and most had multiple manufacturing and distribution locations. Contacts within the specific firms generally included the vice-president of manufacturing/operations and the senior DP manager.

During the course of the study, Booz Allen paid special attention to materials management, the area of U.S. manufacturers' greatest focus during the 1970s. Encompassing the ordering of materials, production logistics and inventory controls, the materials management function controls large amounts of capital and has great impact on the bottom line, affecting both the size and effectiveness of plant investment.

The worldwide struggle toward higher productivity is forcing individual firms and, indeed, entire industries to face an inescapable prospect: the need for substantial investments in computer-driven manufacturing systems that involve every facet of operations.

The power of computers continues to increase at a rate that astounds even the most sophisticated observer; as a result, computer capability is becoming almost an incidental cost of business. But even the biggest and most successful industrial users of the computer are falling far short of their potential in making DP count where it matters most: manufacturing.

The Booz Allen survey revealed an incredible shortfall between actual results and potential in this area — despite the proven value of feasible, installable computerized systems in improving both manufacturing and overall business operations.

No more than a handful of truly effective materials manage-

(Continued on Page 77)

Keys to Japan, Inc.'s Success

Japanese industry has found a better way to produce all kinds of mousetraps. Steel, televisions, automobiles, cameras, home appliances and electronics are all basic industries in which Japan, Inc. is the most productive — and profitable — manufacturer in the world.

Much has already been said about Japan's modern industrial base and the support the government gives industry, through tariffs, tax structure and the like.

But there are other reasons for Japan's success. Its firms do an excellent job of designing and implementing disciplined and results-oriented manufacturing systems, and they manage their businesses by effectively utilizing those systems.

Specific data from the study show how effective the Japanese have been in adapting the new technology. An analysis of the firms in 15 common industry groups showed that Japanese industries were turning their inventories 5.7 times a year, or 50% faster than U.S. and European industries.

Performance varied widely among the 15 individual industry groups. Japanese dominance, however, was clearly evident and 10 of their industries outperformed the U.S. and 14 exceeded European industry performance.

Key areas of concentration for Japanese manufacturing information systems are materials management and efficient production, with a particular focus on systems planning and implementation. In addition:

Management's focus on long-term direction and business strategies ensures an evolution of systems designed to meet future needs.

The thrust of Japanese industry distinguishes short-range and long-range considerations, allowing management to move at deliberate speed to implement well-thought-out systems in a noncrisis atmosphere.

Management's worldwide travel and observation and an attitude open to finding improvements in manufacturing systems add the experience curves of others to its own.

Consensus-style decision making, while time-consuming, fosters understanding and commitment at all levels.

Personnel transfers across functional lines create a broad management perspective. The free movement of personnel also gives management the ability to schedule operations according to need, while building work force skills.

The focus on materials management and efficient production is evident:

End-product schedules are designed to balance customer demand, production capacity and vendor capacity.

Detailed daily schedules coordinate in-house and out-sourced (vendor) supplies and services.

Just-in-time systems place the right amount of material at the right place at the right time, often eliminating the need for safety stocks and economic lot sizing.

Production management operates the manufacturing systems, including computer-aided manufacturing and computer-aided testing. When possible, closed-loop systems are used. ◆

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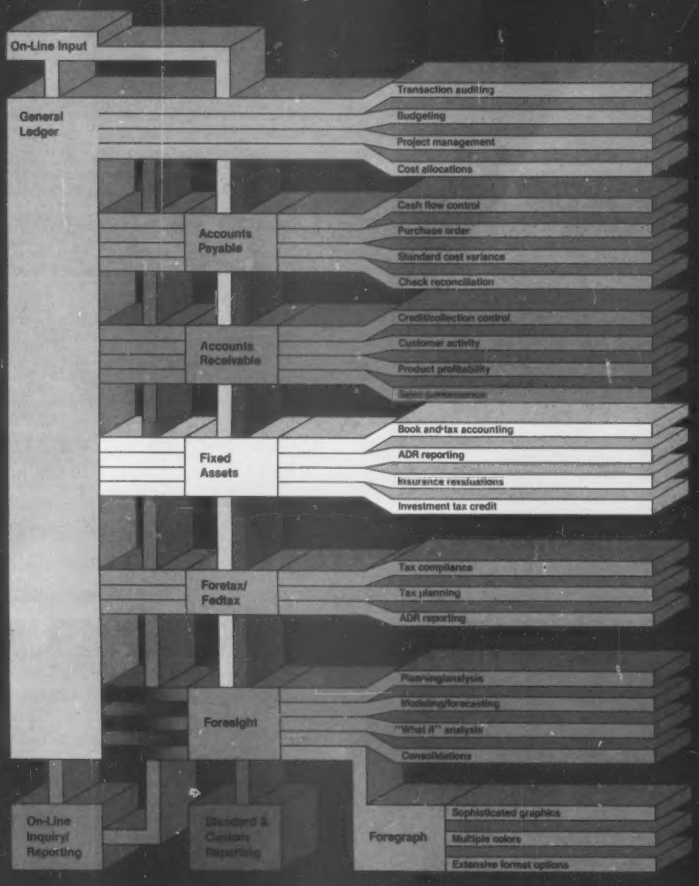

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"Japanese culture facilitates the management of attitudinal and organizational problems."

(Continued from Page 75)

ment and manufacturing systems are in use today, largely because few in top management appear to have realized the critical need for these systems in confronting the complex business problems in the '80s.

The Japanese: Out Front

Japanese manufacturers, the survey revealed, are well ahead of their American and European counterparts and the reasons seem clear. The keys to success in the manufacturing and materials management area included making systems development the responsibility of operations, working carefully to overcome or balance conflicting objectives inherent in different functional areas and providing strong top management direction in systems design. The Japanese business culture strongly supports these needs and almost all their installations have performed very well (see Page 76).

The survey shows that the approach that works for the Japanese is not unique to their culture. The identical approach is used by the few successful U.S. and European companies.

In addition to its 1,480-firm international survey, Booz Allen conducted 84 in-depth interviews with 48 companies in the U.S., 24 in Europe and 12 in Japan. Among the major issues explored were:

- What are the key ingredients of a successful manufacturing system and what is its bottom-line impact?
- To what extent do today's manufacturing systems relate to overall business strategy?
- How will technology and the economic outlook reshape manufacturing systems of the future?

Briefly stated, the survey found that successful manufacturing information systems: play a major role in raising productivity, profitability and competitiveness; have achieved significantly greater bottom-line benefits for their firms; may make the difference between profitability and (in many cases) sheer survival in the 1980s; provide superior inventory management, customer service, asset utilization, overall management control (including decision making) and greater manufacturing productivity.

The study also found that attitudinal and organizational factors were critical to success. Japanese culture, it was found, facilitates the management of attitudinal and organizational problems, but successful European and U.S. firms have also overcome these and other obstacles.

The key implication of these findings for top management: A flexible, well-integrated manufacturing system linked to corporate goals and strategies can play a major role in increasing both profitability and productivity.

Winners, Losers and Comers

The firms surveyed generally fell into five performance categories: the Uninitiated, the Aware but Wary, the Comers, the Losers — and the Winners (see Figure 1 on Page 78). In most cases, successs related directly to the stage of development that a firm's manufacturing information system had reached. The four stages, each increasing in sophistication, number of transactions, data bases, impact and benefits achieved are:

- *Stage I — Transaction:* Focuses on automating records and reports; views the computer as a powerful calculator and typewriter.
- *Stage II — Statistical Technique:* Focuses on the development of broader applications; frequently uses statistical and other quantitative methods.
- *Stage III — Material Requirements Planning (MRP):* Features a major expansion in materials management systems and functions.
- *Stage IV — Manufacturing Resource Management System (MRMS):* A closed-loop system that bridges the gap between manufacturing strategies, day-to-day manufacturing management and financial accountability.

Most winners were found in the two advanced stages: MRP and MRMS; those achieving moderate success had reached Stages II and III. And while the uninitiated, of course, generally received the fewest benefits of all, the losers — those with unsuccessful systems — were found at all four stages.

The number of winners? A handful. Despite the fact that manufacturing firms account for about 25% of the installed computer base and that most of these firms have some manufacturing systems, only 42% of those surveyed reported acceptable results. Only 12% called themselves winners.

Perhaps most dismaying of all: 70% of the firms surveyed did not even audit the results or benefits achieved through their systems.

The primary focus of manufactur-

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ing systems varies by continent, the survey revealed.

Inventory management was the prime benefit sought in the U.S. and Japan, with a focus on materials management. Europe, by contrast, sought increased output with the focus on facilities utilization.

Another principal benefit sought by U.S. firms was better customer service — and here, too, the focus was on materials management. Successful U.S. firms increased their in-stock performance by between 30% and 50%, on-time deliveries by 26% to 40% and shortened delivery lead time by 11%, at the same time reducing split orders by 33%. Japan, on the other hand, sought to lower the cost of goods sold and focused on efficient production.

Materials management emerged as the key area of opportunity for improving the manufacturing function and increasing profitability. The experience of successful firms shows that inventories may be reduced by one-third or more in a low-growth environment through an effective, up-to-date manufacturing information system.

Successful firms did just that: In terms of inventory turnover based on costs of goods sold, they increased their turns 100% between 1970 and 1978. The total U.S. inventory turn-

FIVE PERFORMANCE CATEGORIES

The Uninitiated	The Aware But Wary	The Comers	The Losers	The Winners
Fragmented responsibility for materials — usually at low levels of the organization	Combined some materials management functions — at middle level	Unified materials management — at senior executive level	Senior management lacks understanding of systems and the commitment to use them as business tools	Most have modified materials, production and distribution systems to support business strategies
"Rule of thumb" techniques	Developed some analytical tools	Assigned responsibility for performance objectives	Organizations not tuned to manage materials or balance objectives	Most have formal programs to update systems as business goals and conditions shift
Largely manual systems	Some integrated systems	Developed several analytical tools	Responsibility for objectives not assigned and/or tracked	Extensive on-line and integrated data base systems
Typical Result: Generally achieve few improvements in inventory performance	**Typical Results:** Inventory performance improving — results are scarce	Extensive and generally integrated computer systems	Mistrust of systems and data accuracy at all levels	Simulation, query and "what if" capability
	Management believes that performance would be worse if present systems were not installed — but this is questionable	**Typical Results:** Frequently experience marked inventory improvements	All shapes/sizes of systems — manual through integrated data base	Distributed processing at point of control
		Rank among industry leaders in the management of materials, production and distribution	**Typical Result:** Inventory performance ranges from poor to out of control	**Typical Results:** Most are achieving major inventory improvements and excellent return on investments
				Senior management uses systems to balance customer, production and profit priorities in varying business conditions

Figure 1

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"Successful systems generate early return on investment and provide a pay-as-you-go return."

over average during the same period: up 20%. Successful European firms also improved inventory management substantially, increasing their turns by 35% in the face of industry averages that declined 2% between 1970 and 1978.

Comparing successful U.S. firms with average U.S. firms over the same eight-year period — and assuming seven turns for the successful vs. four turns for the average firm — the bottom-line difference could amount to 29% greater profits for companies in comparable industries. Return on sales could be almost 1% higher.

While all these figures are compelling, three strategic industries in Japan best demonstrate the provable potential of superior inventory performance.

The average increase in turnover in Japan's automotive manufacturing from 1970 to 1978 was only 29% vs. 30% among U.S. manufacturers. However, average turnover favors Japan, 11.9 turns to 5.6 turns.

In automotive parts, Japan increased turnover by 78% for an average turnover level of 11.3 — contrasted with the American increase of 22% and average turns of 3.9 — an almost three-to-one superiority for Japan over the U.S.

In home appliances, Japan has increased turnover by 47% during the past nine years, with an average turnover of 6.5. The U.S. record: an 8% increase in turnover, averaging 3.7 turns.

In electronics — the newest worldwide target for Japan — inventory turnover has increased 30% during the past nine-year period. Average Japanese turnover is 6.0, while the U.S. turns have decreased 12% and averaged 3.2.

Success and Failure Equally Expensive

Materials management — and manufacturing information systems in general — are costly, and tend to range from 2% to 4% of sales in companies with revenues up to $40 million. In companies with sales over $250 million, the implementation costs of major systems range up to 1% of sales, and sometimes more, depending on product complexity, systems features and length of implementation cycle.

Variable cost factors include the time needed for system design and the initial installation cycle. Major subsystems generally take from 18 to 30 months for initial installation and cutover, and up to four or five years for full implementation and routine operation. But costs tend to be much the same for comparable firms over the complete implementation cycle.

Conclusion: Adding up all the costs for systems design, programming and debugging, special software and hardware, personnel training and installation — losers, or those in between, spent the same amount as winners. The cost of failure was, and is, the same as the cost of success, with one exception: Successful systems generate early return on investment and provide a pay-as-you-go return. Winners tend to recover investments from six to 24 months after initial installation and cutover.

Good manufacturing systems at the current state-of-the-art must be flexible and integrated, and linked to corporate goals and strategies; they must never be isolated or operate independently of firmwide objectives.

As noted earlier, the system best suited for the '80s is the Manufacturing Resource Management System — the fourth and most advanced stage in the evolution of manufacturing information systems (see figure on Page 75).

While an MRMS can be defined in a number of ways, it will generally include the following:

- A computer model of the business to ask "What if?" questions.
- A scale for weighing the most profitable trade-offs in a changing business environment.
- A system to plan with and measure operations against objectives.
- An operations-oriented system that balances materials, production, marketing, and distribution activities to meet financial goals.

The key word is flexibility; the successful system must always be adaptable to unforeseen circumstances. But for all its sophisticated relationships and data bases, MRMS is not an automated system in its own right. It must depend primarily on human guidance from the top down and can never replace the need for sound judgment and decision making.

Where do we go from here? Sixty-four percent of the firms that Booz Allen surveyed reported plans to advance from their present stage of information systems development to the MRMS stage. The estimated average time required for the transition:

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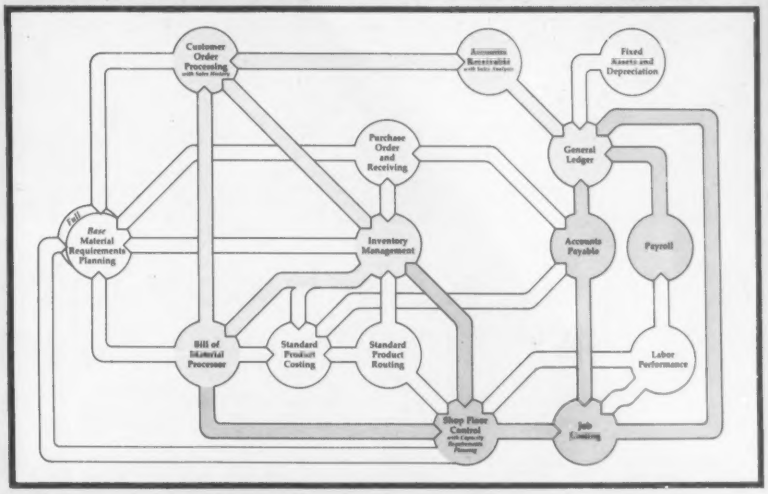

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This movement to "trade up" information systems is assisted by a number of recent developments: new technology, industry-specialized products; distributed information processing (DIP) gains; and integrated application software.

A fifth, very exciting and promising stage of manufacturing information system development — the Manufacturing Productivity Management System — tentatively dubbed MPMS, will gradually phase new technologies into a broader concept of information-driven manufacturing systems by the mid-1980s (see figure on Page 75).

Farsighted firms on all three continents recognize the critical edge that MPMS will give them and are already planning ahead to integrate new technologies into their existing systems. MPMS clearly offers tremendous capabilities and increased benefits through the integration and use of:

- Computer-aided design — shorter design cycles, more standardized designs, more design iterations.
- Computer-aided manufacturing — integrated engineering manufacturing data bases.
- Robotics — materials handling, assembly and production efficiency.
- Computer-aided process planning — greater manufacturing control, more efficient automated processes.
- Automated materials handling — more productive machine tools.

It all adds up to better planning systems with real-time feedback and control. The result: more efficient overall production, better products and higher productivity.

For all the proven and potential benefits of modern manufacturing information systems — particularly MRMS and the more advanced MPMS — the ball remains, as ever, in management's court. One can buy all kinds of resources, human and otherwise, but there are no off-the-shelf solutions to the managerial challenges that these systems present. Booz Allen's worldwide survey found, however, that there was a consistent set of ingredients in successful systems.

Profile of a Winner

The profile of a winner, worldwide, includes four critical success factors:

- *Conflicting functional objectives are balanced through organizational, policy and procedural changes.*

Typically, for instance, a business' manufacturing marketing and finance functions conflict in the areas of inventory investment, customer service and manufacturing costs. Manufacturing demands long runs, a stable schedule and a high inventory investment. Marketing demands quick availability, complete flexibility and a high inventory investment. Finance's key goal is a low inventory investment.

- *Systems are designed to meet both long- and short-term business objectives.*

Basic reporting and record disciplines are instituted to support the manufacturing information system; data bases are created prior to implementation. Realistic and agreed-upon schedules and milestones are established between users and DP personnel, and an ongoing update program to reflect changing business needs is created.

- *Sufficient management resources are invested at all levels to ensure success.*

Senior management provides direction and is involved throughout the project; functional management and DP designs the conceptual systems, defines its goals and objectives and accepts full accountability. First-line management implements the system and provides feedback and accountability.

- *Employees of all types and at all levels are educated about the new systems and "what's in it for them."*

Personnel require delicate handling — education, hands-on training, incentives for progress and continuing support and reinforcement from management.

Finally, application software — a critical aspect of DP — will evolve as a fifth critical success factor in the '80s. More basic applications will have to be purchased and manufacturers will have to modify them to meet unique requirements. Software may well become the pacing factor on the road to success in manufacturing systems implementation.

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Harker is a vice-president of Booz Allen & Hamilton, Inc. and leader of it Manufacturing Systems Practice. Fox is a vice-president in the Operations Management Division of Booz Allen. ◆

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By William B. Engle

HIGH-LEVEL LANGUAGES:

The User/DBMS Link

No matter how capable the data base management system (DBMS), its benefits can be realized only through user/system interfaces that facilitate and support the use of the system and the data resources. Much emphasis should be placed on the user-oriented aspects of the interface.

The user/system interfaces of a DBMS fall into two basic categories: the programming language interface, or data manipulation language (DML); and the query language interface (QLI). Use of the DML requires programming expertise, whereas the QLI was designed for use by nontechnical end users. DML statements are embedded in the "host" procedural language (Cobol, PL/I, Assembler) in which the application programs are written. Because the semantics, or power, of the host languages is increased, the DML is considered to have extended the host language. Of

the DMLs available today, most are rather primitive as languages; they are simply a set of commands used to access and manipulate data. They are affected by their inclusion as parameters in a subroutine-calling sequence of the host language. Some general examples of DML commands are OPEN, CLOSE, GET, INSERT, DELETE and ORDER.

The structure of the DML enables the programmer to examine the results of each call on the DBMS and to perform appropriate actions. These actions may include accumulations, sophisticated calculations, decisions and branching and even retrieval or update of data in conventional files not under the control of the DBMS. Although some QLI capabilities that are available on the market may perform one or more of the same functions, none can offer the power available in a DML.

Factors that should be considered when examining a DML include:

- The data retrieval and manipulation functions that can be performed in the DML.
- Program/data independence.
- Security and privacy.
- Error detection and responses.
- The extent to which DML is compatible with the architecture of the DBMS.
- The ease of coding, testing and debugging.

DML syntaxes vary significantly, but their functions are not entirely dissimilar. Regardless of the syntax involved, the DML must communicate certain details to the DBMS to enable the DBMS to "understand" what the programmer wants done. In some DMLs, the user must explicitly code most of these details; in others, the DML itself generates and passes some details to the DBMS. In either instance, details include:

- The function being performed (for example, INSERT or GET NEXT).
- The program location containing data to be passed to or from the DBMS.
- The location to which information is to be returned from the DBMS. This information may include counts of records processed position indicators, the name of the record type, date and time information and other data that may be of interest in determining further program processing or may be displayed in the event of an unexpected condition.
- Search logic (for "keyed" retrievals).
- Function modifiers (specifying selected alternatives for performing the utilized function).
- A description of the data being processed, instructing the DBMS on which fields are to be returned to the data area and in what formats.
- Additonal information about certain selected calls in specific packages.

Not every DBMS requires or permits this information, nor is it used on every call. For instance, search logic may be used only on functions that search the data base or its indexes. Data descriptions may not be required when logging, checkpointing, or other nondata functions are requested.

It is important to note that the presence of functions in a DML does not imply that the DBMS is geared to processing such calls efficiently. Theoretically, most language capabilities can be interfaced to any DBMS architecture. Although most vendors have developed DML capabilities designed to utilize the best architectural features of their packages, marketing-induced eventualities can reduce the degree of correspondence between the DML and the DBMS architecture.

DML Preprocessors

So far, we have focused on the nature and functions of DML directives without regard to either syntax or ease of use. DML directives may be in the form of CALL statements on DBMS routines, or they may be in a higher-level language that must be translated into a call. Such translation is usually accomplished through a preprocessor supplied by the DBMS vendor. Alternatively, users may write their own preprocessors, or preprocessors may be supplied by independent vendors.

A preprocessor usually helps the programmer to write fewer lines of code. In addition, because preprocessors usually provide mnemonically straightforward syntaxes, the programmer will make fewer coding errors and the program will compile more quickly. Unfortunately, these features are often viewed as the only benefits of a preprocessor.

There are two additional benefits often overlooked in preprocessor evaluation. The self-documenting code is of great long-term importance. Ease of testing and debugging may be the most important benefits of a preprocessor, but they are often overlooked even by the marketing departments of vendors that offer preprocessors.

Query Language Interface

The QLI to a DBMS provides a user that is not a programmer with the capability to express a request for information from the data base, select the necessary data, structure and/or associate the data and return the information.

Although QLI capabilities vary in sophistication, the following basic set of functions must be present in a QLI. The user must be able to specify:

- The action to be taken.
- The data type or types on which the action is to be taken.
- Qualifying characteristics that determine whether that action will be taken.

Thus, in the theoretical directive:

"PRINT ALL PERSONNEL RECORDS FOR PERSONNEL WHOSE DATE-OF-HIRE IS 03/21/81!",

the word "PRINT" is the action to be taken, the phrase "ALL PERSONNEL RECORDS" is the data type on which the action is to be taken, and the phrase "FOR PERSONNEL WHOSE DATE-OF-HIRE IS 03/21/81" is the qualifying characteristic that determines which personnel records are to be printed.

QLI capabilities are designed to bypass several steps in the programming process: coding, keypunching, debugging and testing. In the majority of environments where QLI processing is made directly available to the users, the communication between users and programmers can be reduced or eliminated as well. Bypassing these time-consuming processes enables the QLI user to generate information within minutes in many instances.

Although ad hoc processing and responsiveness to nonstandard management information requirements have formed the "traditional" role for QLI, there are other needs that it can satisfy. These additional roles are not often assigned a great deal of importance in determining QLI processing needs. Nevertheless, these factors must be recognized and included in any evaluation. These factors include QLI in production operations and QLI as a programming aid and administrative tool:

QLI in Production Operation

QLI processes rarely perform as efficiently as DML routines and should not, as a rule, be used for "production" systems. However, there are two circumstances under which a QLI could be used for production systems:

- QLI can be used as a "stopgap" measure, to meet an information need for which manpower has not been allocated to code and test a DML program. Every effort should be made to hold QLI programs of this nature to a minimum and to allocate human resources to such projects at the earliest possible date.
- For infrequently performed operations, such as annual processing or some seasonal processing, the cost of QLI may be less than the programming costs amortized over the life of the application program. Careful analysis should be performed before these decisions are made.

A large portion of a programmer's time is spent is creating "dummy" data for program testing and in writing extraction programs or using utilities to test the results of update programs. Using QLI can reduce these costs. It can make the programmers' tasks easier, increase their productivity and, in many cases, improve their morale.

Costs Involved

In addition to the software cost for QLI processing (up to $50,000 for the license fee), there are costs for hardware and for educating users.

A QLI module, unlike a program

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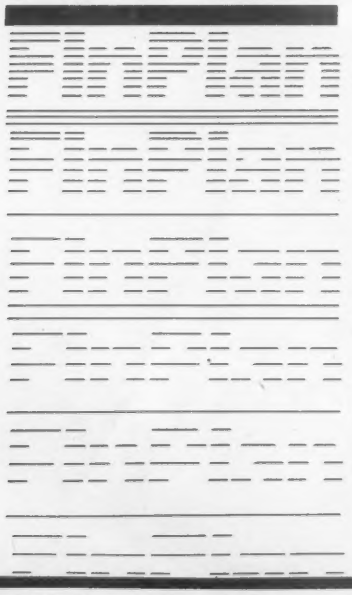

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"QLI modules contain specialized ad hoc logic that is present even when the user does not request it."

written for a specific application, must be capable of performing a large number of processes. QLI modules are generalized software and have been created to service the widest possible spectrum of processing requirements.

Thus, QLI modules contain specialized ad hoc logic that is present even when the user does not request it. Furthermore, QLI modules must interpret user queries. This necessitates scanning, editing, table lookups and reformatting before actual requests are made on the data base. QLI modules must also format output as user specifications direct.

QLI processing entails CPU overhead, caused by the scanning and interpreting functions. The more sophisticated QLI logic modules may add as much as 100K bytes to the storage requirements. Although in most cases, this can be overlaid or placed in virtual storage, it can have an impact on the efficiency of QLI as well as other processing.

Many vendors claim their ad hoc capabilities can be used after only a few hours of training. This is probably true for less sophisticated queries. There is a difference, however, between using a QLI in its most rudimentary form and knowing it well. Formal training in the use of more sophisticated QLI processes may require as long as a week of classroom activity.

The following subsections provide a brief description of the DML and QLI facilities that are available for each of the best-known DBMS.

• **Adabas — Software AG of North America, Inc.** Acting as a host language system, Adabas meets programming language interface requirements through the Adamint macro facility that provides the application programmer with a high-level call interface. Adamint contains a module that allows access to, and manipulation of, a select subset of the data base for each user view. Access can thus be limited to the data actually needed as expressed in the user view.

The standard query language interface is for Adabas Adascript+ with a higher level language, Natural, available at optional cost.

Adascript+ is an interface module that permits the use of Adabas as a self-contained system. It can be used in batch mode, but is most commonly used from on-line terminals. Adascript+ is an easy-to-use English-like language that can be taught to non-DP operating personnel in two or three hours. Frequently used Adascript+ queries can be cataloged; a macro facility further simplifies their reuse.

Adascript+ offers other extensions that provide limited report writing capability, including:

- Simple arithmetic statements.
- Headings and captions.

"Natural" is a powerful, natural language that provides end users as well as programmers with an easy-to-use facility for ad hoc data base inquiry, updating and report generation. Natural can also be used for screen format generation, data entry through predefined screens and on-line transaction processing. Non-Adabas files can be processed. Natural facilitates the relational data structure by allowing users to process, in one program, logical relationships from data in several different files, or data from an individual file in several different ways. The data dictionary is required if Natural is to be used to access Adabas files.

• **Datacom/DB — Applied Data Research (ADR).** Application programmers access Datacom/DB through call statements giving as parameters the search arguments of the key and the list of data elements desired. Any number of data elements can be accessed in a single call. Programs can be written in any language supporting a call statement. Programmers can also use Datacom/DB, a data definition language that is essentially an extension of Cobol allowing a high-level, logical definition of the data to be used by a program. Datacom/DB statements must be translated by ADR's Metacobol processor.

The query language interface for Datacom/DB is provided by the optional Dataquery package. An English-language query facility, Dataquery can operate through any teleprocessing network to inquire into and analyze the contents of any Datacom/DB data base. Its Boolean logic abilities, together with the semirelational structure of the data base, allow very complex queries to be specified.

• **IDMS — Cullinane Database Systems, Inc.** Programmers manipulate data in the IDMS data base through a series of DML commands. Cullinane's DML is a procedural data base programming language used in

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High-Level Languages

conjunction with Cobol, Fortran, PL/I or Assembler. Use of IDMS with other languages is accomplished using a mapping (which Cullinane provides) between each DML verb and the CALL function.

In the Cobol environment, the programmer's working storage section, representing all the records to be accessed under the program's associated subschema, is constructed by the system. To use the DML, the programmer need only insert the commands into the source program. The DML processor checks the syntax, validates the logic, flags errors and converts the commands into a format compatible with the source language.

Cullinane offers a choice of two query language interfaces, On-Line Query (OLQ) and On-Line/English. OLQ provides data base access by means of a simple, English-like command language. Results can be displayed on a CRT terminal or can be printed. Data can be retrieved in either logical or physical data base position, or by index value. Using Boolean logic, OLQ allows users to concentrate record selection criteria by means of logical connectors. Users can catalog frequently performed command sequences.

On Line/English uses the English language (as opposed to an English-like equivalent) so that requests can be submitted in normal conversational terms. On Line/English accepts ordinary English phrases, interprets them into computer terminology, retrieves the requested data, performs simple computations when necessary and displays responses to the requests.

• **IMS/VS — IBM.** IMS/VS (as well as its DOS counterpart, DL/1 DOS/VS), makes no provision for direct application code. The user writes application programs in Cobol, PL/I or Assembly language, for which interface modules are provided. For access to the data base, DL/1 commands are inserted in the source program. These commands eliminate the need for file descriptions and procedural coding for data base access.

IBM's program product IMS Application Development Facility II (Adfii) is available as an aid in program development for IMS/VS. Adfii operates interpretively, providing a prompting function through menus on a 3270 screen.

The IMS/VS user has two choices of interactive query facilities from IBM as well as two packages that are available from independent vendors. The two IBM products are:

• **Interactive Query Facility (IQF).** This facility allows the applications programming function to be performed at a terminal. With no knowledge of programming, the user can instruct IQF to list and count data fields, perform sorting functions and format the output. Since IQF data bases are also IMS/VS data bases, IQF can also use the many data base utility programs available to IMS/VS.

• **Generalized Information System/VS (GIS/VS).** GIS/VS is a structured-file information handling system designed for a dynamic operational environment. Combined with IMS/VS, it provides a set of generalized routines that enable data set creation, maintenance and retrieval. The user describes new or existing files ina procedure that does not require detailed programming. These file descriptions enable the user to address the contents of files by means of symbolic names.

The two IMS/VS query packages supplied by independent vendors are:

• **ASI/Inquiry — Applications Software, Inc.** With this facility, which operates as an IMS/VS message processing program, inquiries are stated in an English-like language that provides comprehensive selection logic and information display. Data selection is based on "and/or" logic, with parenthetic notation allowed. The hierarchical structure and segment logic of the data base are transparent to the user. Advanced data base concepts can be utilized without writing the highly procedural programs usually required to access data bases in a message processing environment.

• **Inquiry IV/IMS — Informatics, Inc.** Inquiry IV/IMS is a natural interactive data retrieval language designed for all users regardless of their technical orientation. It operates on any terminal supported by an IMS or Time Sharing Option system and allows the searching of physical, logical and multiple data bases to satisfy an inquiry while maintaining security of the data base and performance integrity for system resources.

This is accomplished through a user directory, which profiles the data fields and system functions that can be accessed and limits the amount of

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"Inquire is unique in providing for text storage, manipulation and retrieval in addition to the usual DBMS capabilities."

processing at a given time. The basic language (which can be tailored to each installation) allows the end user to select, manipulate by arithmetic operations and sort and display detail and/or summary data at the terminal or in batch mode based upon specific conditions.

The definition language (an extension of the basic language) allows the user to store frequently used or lengthy inquiries or arithmetic operations in a directory to be called out by using a simple code, eliminating the need to input the same inquiry repeatedly. The definition language reduces the need to write Cobol or PL/I retrieval programs.

• **Inquire — Infodata Systems, Inc.** The Inquire DBMS supplies a DML that enables application programs written in Cobol, PL/I, Fortran or Assembler to update and retrieve information through the use of a call facility. Requests are made by passing control blocks as parameters to CALL statements. Because fields are specified by name, programs are independent of the program structure. Precompiling is not necessary.

The self-contained Inquire user language provides an effective query language interface. The language implements the functions of information retrieval and report generation, data base maintenance and administrative control of processing by way of an English-like syntax.

Queries can retrieve data either by direct (keyword) or sequential (field-value condition) searching of data bases or by a combination of both methods. Selection criteria are connected by the Boolean operators AND, OR, AND NOT and LINK. The LINK operation implements an AND operation between corresponding elements of repeated fields. Direct-access retrieval can be accomplished by specifying keyword roots as well as complete keywords in the selection criteria. The user language provides data manipulation and report generation facilities for the retrieved data.

Inquire is unique in providing for text storage, manipulation and retrieval in addition to the usual DBMS capabilities.

• **Model 204 — Computer Corp. of America.** A host language interface provides the basic retrieval and file maintenance tools for operating on Model 204 files. Data requests from a file are initiated with a FIND statement and its associated parameter set: selection criteria consisting of various field names and values related by operators and comparatives are specified.

After accepting a statement, the system extracts the key/value criteria of the specification from the index area. The retrieved index entries are manipulated to resolve the specified comparative relationships, yielding the set of file records that satisfy the specified selection criteria. The user can then issue GETs against the selected list. It should be noted that the actual data record is accessed only when a GET is issued.

A query language interface for Model 204 is furnished by the User Language option. The Model 204 user language is one of the more complex and sophisticated query languages, but is very highly regarded by users who find it easy to learn and use.

• **Ramis II — Mathematica Products Group, Inc.** The Ramis II system offers an optional Procedural Language Interface that allows retrieval and maintenance of data base records in any specified format through calls from Cobol, PL/I, Fortran or Assembler programs. Fields are referenced by field name or description, are automatically accessed and the data is communicated to the program's work area. The Ramis II data base management facility provides the necessary hierarchical and network interconnections.

The query facility for Ramis II is its built-in language processor that accepts free-form, nonprocedural, English-like statements. A large repertoire of commands can be used to define, access and maintain a data base; create reports in a user-defined format; generate graph data; create catalogs of frequently used procedures; and build macros of various Ramis II functions.

The language is straightforward, yet offers such sophisticated abilities as table lookup, concatenation of character strings and highly complex mathematical operations.

• **SQL/DS — IBM.** IBM has recently introduced SQL/DS as a "new relational data management system," falling somewhat short of billing it as a full-blown DBMS. Since SQL/DS is offered as a complement to the DL/1 DOS/VS data base management package and is highly query-oriented, a discussion of the major query languages would not be complete without including this new-

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High-Level Languages

comer. SQL stands for Structured Query Language. SQL is a high-level data language available to users through a CICS/DOS/VS transaction (or equivalent), a batch utility and application program.

The language supports data definition, access, manipulation and control operations.

SQL statements consist of command verbs, optional clauses, language ke, words and parameter operands. The structured use of verbs and keywords in the SQL syntax allows precise specification of data requests in a readable fashion. SQL statements and commands can be entered from a terminal for query and report formatting operations without any applications programming.

Frequently used queries can be saved for later use. On-line reference information will be saved for later use. On-line reference information will be provided upon request, including end-user-oriented explanations of SQL statements, terminal commands, messages, system catalog tables and the like.

Although there are many varying options regarding the significance of the SQL/DS announcement, there can be little doubt that, with SQL, we are at least being given a preview of the query language interface for the upcoming IBM relational DBMS.

• System 2000/80 — Intel Corp., MRI Division. In addition to the basic programming language interface functions performed by a DML, Intel provides a higher level programming language extension for System 2000/80, called Plex. Plex allows applications programmers to combine Cobol, Fortran, PL/I or Assembler statements with System 2000/80 syntax to produce relatively simple routines that can perform complex data base tasks.

Relational Boolean selection criteria can be used. Simple directives provide a convenient method for manipulating the data in one or more data bases. For example, the user can dynamically locate a subset of the data base that meets specified criteria and then get only the selected records. When structured views of the data are not appropriate, Plex allows definition of relationships between two record types, based on common or associative keys.

Intel offers a choice of two subsystems for use as query language interfaces, Quest and Quex. Quest, which has been in use for some time, is an English-like relational language facility that can be used by either programmers or nonprogrammers for creating and updating data bases as well as for ad hoc retrieval. It can be operated in either on-line or batch mode.

Quex (Query/Update by Example) has been recently put on the market as a general-purpose on-line data base management program that can provide access to data without the need to learn a specialized data access language. In operation, the user is presented with a menu of items that are authorized for access.

• Total (and Total Information System) — Cincom Systems, Inc. Communications between application programs and the Total data base are accomplished by means of the Total data management language (DML). The DML relies on the host language to furnish the framework and procedural capabilities needed to perform the data management functions. The DML functions with the host language at the call or macro level to open or close files and retrieve records. Any language with a call or exit facility is acceptable to Total.

Cincom offers two optional query language interfaces, T-Ask and TIS/Query. T-Ask is a well-established package that is being used by more than 100 Total DBMS installations; TIS/Query is a new higher level product designed for use with Cincom's Total Information System (TIS). T-Ask is an on-line, directory-driven interpretive query processor that uses an English-like syntax. T-Ask's data directory contains data names and their attributes, relationships between data names and relationships between data names and users.

Besides the query mode, T-Ask operators in a directory maintenance mode for the data administrator and a catalog mode that allows users to execute previously cataloged procedures. TIS/Query offers all the capabilities of T-Ask, but at a higher level of user friendliness. It is designed specifically for use with Cincom's newly developed comprehensive TIS software.

Engle is Software Editor of Auerbach Computer Technology Reports, *a publication of Auerbach Publishers, Inc., Pennsauken, N.J.* ◆

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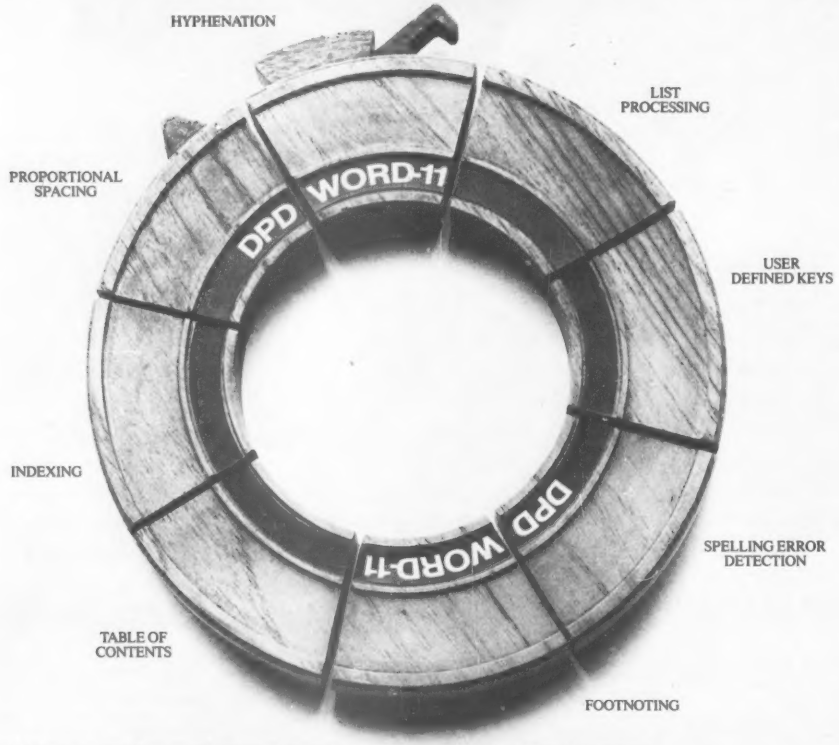

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By Donaldson Richmond

No-Nonsense Recruitment

The human resource is the one major resource that the industry is short of. It is, therefore, the major constraint to expanded application of the technological advances that are taking place in the data processing industry today. The lack of any kind of concentrated effort within industry at large to address the recruiting problems has spawned the birth and growth of some very large satellite industries, which include contract consulting firms, software houses and employment agencies and search firms.

This article will review the recent growth history of the computer industry and the need to modernize its personnel acquisition process. It discusses the impact of rapid and prolonged growth on salaries in the industry. It also takes a look at what effect this growth has had on the data processing professional marketplace. The first section wraps up with a look at the implications and needs users of computer equipment must come to grips with. We will also review search firms, employment agencies, contractors and contracting firms as alternatives to the personnel acquisition problems.

The computer industry is growing at a phenomenal rate. There is a 213% disparity between the growth rate of the industry vs. the growth rate of its human resource component. This provides some useful insights into the shaping of a contemporary perspective on a service industry that is having a fundamental impact on industry at large. It is an all-encompassing impact that will increase in severity for several years to come.

This presents a big problem to the computer industry and industry at large. The major purpose of this article is to identify some of the major factors causing the problem. It is also to provide some insights into the depth and character of the problem and what its trends indicate for the 1980s. Further, it out-

No-Nonsense Recruitment

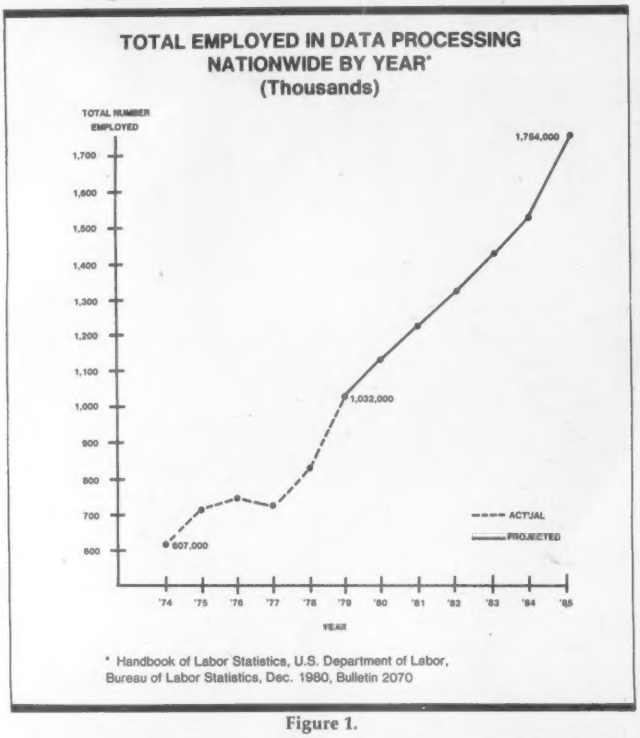
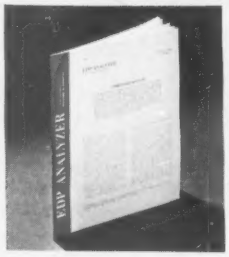


Figure 1.

Productivity is the issue



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lines a methodology to resolve what are essentially growing pains.

These growing pains take on more meaning when viewed in terms of the industry's actual growth. To appreciate the magnitude of the recruiting problem the industry is facing, it is necessary to examine some statistics produced by the U.S. Departments of Commerce and Labor. An examination of some of the data for the manufacturing component will help shape the perspective on how intense the vigor of the industry's growth has been.

For example, the U.S. Department of Commerce reports that in 1975 the value of shipments by manufacturers of electronic computing equipment was $8,560,000,000. In 1981, the value of shipments is expected to reach $32,800,000,000 for the year. This represents a 283% increase in volume over a six-year period. If that trend continues over the same number of years, then by 1987 the value of shipments will be in the neighborhood of $125,624,000,000.

Given that this is an industry that feeds hungrily on its own advances, there is no reason to expect the trend to subside. By 1993 the value of shipments in unadjusted dollars could reach $481,140,000,000, or almost half a trillion dollars. This is a staggering rate of growth, as it would be for any industry. This growth creates many voids in the continuity of many aspects of the industry, not the least of which is personnel acquisition and attrition.

The growth in the utilization of electronic computing equipment has been accompanied by sharp growth in the number of trained people necessary to operate, program and service the equipment (see Figure 1). The U.S. Department of Labor reports the number of computer specialists, programmers and systems analysts employed in the field increased from 607,000 in 1974 to 1,032,000 in 1979, which is a 70% increase. This means the industry was in excess of 300,000 people short of its needs when the year 1981 began.

The Labor report did not include figures for 1980 and 1981, but some industry analysts believe we can expect the number to increase in 1981 by approximately 36% over the 1980 levels.

Analyzing the growth data, we find some very interesting observations. For example, between 1975 and 1977 the U.S. economy experienced a downturn. This was probably due in part to the transition from a war-stimulated economy to a peacetime economy. In Figure 2 on Page 90, we see the growth rate of data processing professionals took a big drop relative to the growth rate of all white-collar workers in the country. But in the two following years, the industry began a dramatic climb that, even today, has not leveled off. By 1985 the total number employed in the industry will exceed 1,754,000 people, and 2,982,000 by the year 1990.

The growth of hiring activity and its competitive intensity becomes clearer when viewed in terms of the daily activity. For example, when the year 1981 started, the industry was hiring an average 930 people daily, and by the year 1999 that number could exceed 2,688 people each day.

The impact of the growing shortage is reflected in the salary history of the industry. A salary survey by Source EDP, an established national employment firm that placed about 35,000 people in 1980, indicates the average salary for senior programmers with two to four years' experience increased by 56% over a five-year period — from 1975 to 1979.

From the data in Figure 2, we see the salaries of all professional and technical workers (dotted line) in the U.S. were impacted by the economic downturn. It is interesting to note the degree of downturn experienced at both the entry and senior levels. This clearly demonstrates that the brunt of the downturn was borne by these two levels. Further, while the intermediate level experienced a slowdown, the salaries of this group continued to climb.

Today's experienced professionals want more than just a job; they want a career, an opportunity to embellish and enhance their existing skills in data processing. They are quite willing to move from company to company in order to obtain any background desired or perceived as needed to accomplish their career objectives.

After putting together the right combination of skills and knowledge, the individual will then offer himself to the highest bidder. It is little wonder the industry regularly experiences an attrition rate that annually averages around 30%. The overall human resource market for data processing professionals today can safely be characterized as a "buyer's market" — and the sellers are keenly aware of it.

The attrition rate is largely a factor of high demand for experienced personnel. From 1982 through 1987 the data processing industry will absorb more than 750,000 new people into it. That is a substantial figure for a six-year period. Yet, as curious as it may seem, this shortage is not at the heart of the problem. This gap is obviously being filled by inexperienced people.

The real problem is a shortage of trained people. This is due to the simple fact that no such pool of experienced people will be entering the field. Even though computer science college graduates top the most-wanted list, the need cannot be filled from that pool.

In addition, there are no colleges in the nation that offer the application and business exposure that can be gained by working in the field. Thus, there is no choice but to seek experienced people from the existing pool of resources. The basic problem is a function of the laws of supply and demand. At the end of 1977, a rate of climb out of the recession began that is so strong it has not yet leveled off.

Being in such high demand, the experienced professional is on the

"Reasons recruiting efforts fail today are a lack of recruiting standards, inadequate planning and a deficiency in interviewing skills."

move. In some geographic areas of the nation, the problem is aggravated by the population shift to the sunbelt.

Moreover, the attrition rate is also a function of other natural forces in the computer industry's universal environment, the dynamics of which are outside of the industry's ability to influence deliberately in any manner. This places great stress on the manufacturing industry, which is still reeling from the trauma of one and a half decades of war, recession, inflation and the realities of natural energy shortages.

For the college student graduating with a bachelor's or Ph.D. degree, who even today can expect to start at approximately $20,000 and $30,000, respectively, it means they will continue to be among the most highly paid technical graduates in the nation.

For those entrusted with the industry's management, it includes the following implications:

- The intermediate-level professional is most in demand.
- This is where the most critical personnel shortage lies.
- The competition for this level will continue to expand in intensity as the industry expands.
- The problem is industrywide, thus industrywide solutions are needed.
- Something must be done to assure the industry that a relatively equal distribution of trained personnel across it will occur concurrent with the expansion.
- The recruiting function will enter a period of rapid maturation.

Finally, it is reasonable to assume users of data processing will become more skillful at personnel acquisition as the tenure of their exposure to recruiting in a resource-scarce environment increases. Thus, we are likely to see a very tactful, methodical and disciplined approach to the acquisition of professional human resources.

The need, therefore, is to find some method or technique that will minimize attrition, that at the same time will raise the quality of the industry's recruiting skills and that will provide some way of consistently attracting and hiring from the available resources. Unless the industry recognizes these needs and develops some systematic approach to address the problems, it could find itself facing the old problem of raiding talent from other corporations.

Alternatives and Solutions

The major reasons recruiting efforts fail today are a lack of recruiting standards, inadequate planning and a deficiency in interviewing skills. The average data processing recruiting effort today generally has no corporate or long-range focus. Those individuals involved usually have conducted only a superficial unintegrated planning effort.

More important, only a few have had any type of training in recruiting and interviewing. Recruiting is a competitive process and it must be approached in that manner.

Those firms that develop a systematic approach to personnel acquisition will lessen their susceptibility to bad hiring decisions, high personnel turnover, missed target dates, high recruiting costs, poor staff development and many other problems.

The problems can be solved simply by giving recruiting the same care in strategic and tactical planning, organizing and execution that any other fundamental corporate function would receive.

Some believe the recruiting task can be accomplished by making use of search firms and employment agencies, and to a degree this is true. But it is also true that any recruiting endeavor conducted in conjunction with an agency must be preceded by the corporation's internal planning and organizing effort.

The irony is that, if the hiring activity is unsatisfactory, this could lead to a loss of confidence in the agency even if the basic problem is the employer. Moreover, the unsuspecting employer can easily be taken advantage of by the unscruplous personnel agent or firm. This can take many shapes and forms.

The most common is the dual-agent approach, where the agency gains knowledge of an employer's cadre of professional expertise by soliciting business with a firm, but uses that knowledge to recruit from the employer for another firm. Search and employment firms can be used for recruiting, but the employer must do the preplanning necessary to present the agency with a clearly defined set of requirements.

After all, even if the agency succeeds in locating candidates, it is the employer who must make the final hiring decision; who must assess the

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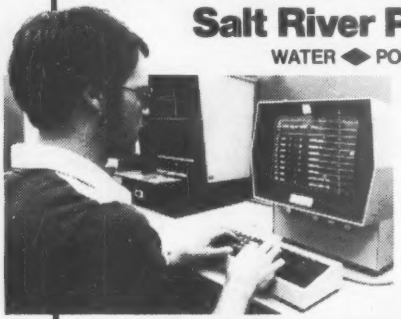

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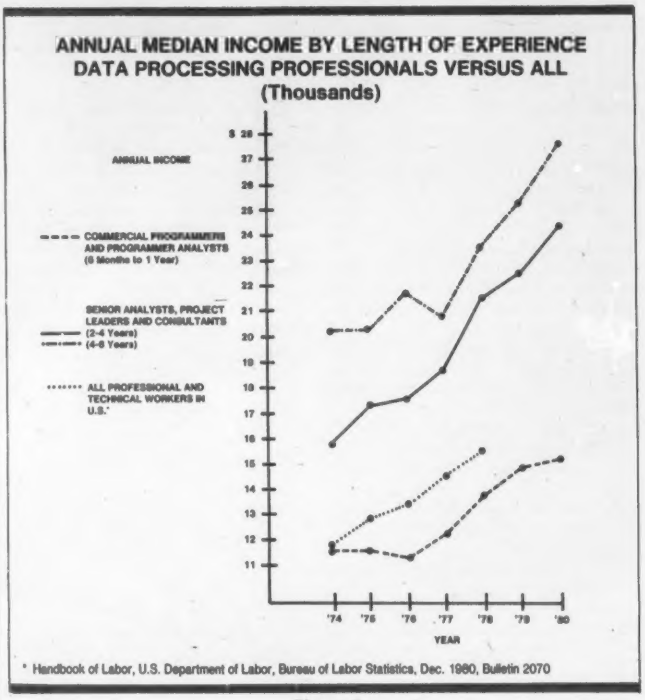

Figure 2

candidate's strengths and weaknesses; who must determine the candidate's career goals and objectives; who must assess the candidate's relative abilities and map those against the firm's needs. It is the employer who must certify and manage the personnel firm, and, in the end, must accept the ultimate responsibility.

If the employer's recruiting campaign is not meeting with success, he can always resort to contractors to accomplish the data processing objectives. But one must consider the trade-offs of this approach. Contractors are very expensive, relative to permanent staff. Their rates are often more than twice that of their counterparts. They usually experience a learning curve while becoming acquainted with the customer's project.

Complicating this, a second learning curve is experienced while they become acclimated to the new environment and the employer's shop conventions. Unless this was planned for by the client, precious time is lost on the project schedule, which erodes the viability of the planned target date. In addition, contractor expertise is not retained by the hiring organization.

Contractors can also have an adverse effect on employee morale. Consider the employee with perhaps four years' experience who is earning around $30,000 annually in salary, which translates to about $15 per hour. That is a relatively fair wage for anyone with only four years' experience who may or may not have a college degree. When that employee is exposed to a contractor of roughly the same experience and background who is sitting at the desk across the aisle, yet making $35 per hour, which is $72,800 annually, the permanent employee has to question the rationale of his own situation.

The fact that firms are willing to accept the trade-offs and risks that are associated with the use of search firms, employment agencies and contract expertise suggests that, within reason, they are willing to do whatever it takes to get the job done. But the biggest deterrent to success at personnel acquisition is the data processor himself.

That is akin to saying that we have met the enemy and he is us. But it's true. It is inherent in our nonprofessional approach and attitude toward recruiting. It is a constituent part of the reluctance to face the issue head on. Indeed, many organizations and managers firmly believe that it is impossible to recruit enough permanent staff each year.

Falling victim to that self-fulfilling prophecy, they regularly allocate a portion of the annual budget to contractors and agencies. This approach and attitude is reminiscent of the programmer's attitude toward documentation during the '60s and '70s — it is a necessary evil ... Leave it alone ... It might go away.

But it won't go away on its own. It will disappear only after the industry's management begins to view and treat recruiting as a basic corporate function upon which much of its success is dependent. The documentation function is a good example of a necessary evil that was addressed by the establishment of standards and methodologies.

Primary Impetus

Even though the government had published minimum documentation standards, the primary impetus for the change comes from within the

"Today's trend toward structured analysis and design, which is becoming a standard, begs good documentation."

industry itself. It is generally known as structured methodology and techniques. Today's fashionable trend toward structured analysis and design, which is becoming a standard, begs good documentation. And it's getting it, as we see a parallel trend of data processing departments embracing the use of word processing equipment and professional technical writers.

Consequently, a professional approach to documentation is beginning to emerge. Thus, many of the historical documentation problems are beginning to disappear. This clearly demonstrates not only the power and influence of establishing standard methodologies and techniques, but also that the industry can deal with broad-based problems in a systematic way.

There are signs that the industry is beginning to perceive the depth of the problem and what can be done to address it. For example, a medium-size bank in San Francisco has been on a recruiting campaign in Europe and Canada for the last three years. Many firms are establishing "bounty" programs, in which employees are paid up to several thousand dollars for each new hire they are able to attract to their company. Still others are paying the new hire a bonus for deciding to accept employment with the company.

However, these tactics, which have met with a degree of success, are designed to *attract* candidates, to bring employers and candidates face to face. While these tactics may be preferable to wholesale raiding of other companies, what is needed are programs designed to evaluate and *capture* candidates. The industry needs programs that will prevail over the long run. They should be living programs, they should encourage development and, above all, they should be flexibile and responsive to the dynamics of the industry.

Many problems associated with recruiting disappear in a manner similar to the documentation problem simply by establishing and practicing standard methods. This is particularly applicable to recruiting efforts where the need is for recruiting several people. Outlined below is a suggested set of minimum standard considerations.

Personnel acquisition efforts should be viewed and conducted as campaigns. When this is done, a systematic approach to achieving the campaign objectives may be developed.

The *American Heritage Dictionary of the English Language* defines a campaign as: 1. "A series of military operations undertaken to achieve a specific objective within a given area"; 2. "An operation undertaken, as by means of propaganda, to obtain some political, social, or commercial goal."

Personnel acquisition efforts are not military operations, but they are competitive endeavors and thus very similar in nature. As such, they have many things in common with military campaigns. Both require thoughtful preparation and precise execution to maximize chances of success. Both require effective communication, teamwork and timing. Also, personnel acquisition and military campaigns require strategies and tactics.

One can develop a methodology based on any combination of facts, events and their relationships to each other and the environment in which the methodology is applied. In this manner, a methodology provides its practitioner confidence in his ability to successfully achieve any goal within the domain of real possibility; the complexity of the task may range anywhere from simple to extreme.

At this point, the practitioner has a functional perspective on how to construct and execute experiments following the rules of the methodology and how to prove or disprove a theory that has been developed to this stage. Adherence to the basic rules of a methodology provides its practitioner a handy tool for avoiding dangers and pitfalls that might otherwise go undetected.

Further, the chances that one can anticipate and manage a situation to a desirable outcome are appreciably enhanced. Moreover, personnel acquisition campaigns usually require teamwork of some sort.

The planning process should be divided into strategic and tactical planning. Strategic and tactical goals and objectives should be identified. A team should be identified to conduct the campaign. Ideally, the team should consist of those most skilled at recruiting and interviewing. To help minimize the loss of good candidates during the interview process, training should be provided.

All phases of the plan should be documented, distributed to all team

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members and modified as its strategical environment changes. The campaign itself should be structured in character. It should have phases that are closely monitored as the campaign moves through completion of the tactical objectives to the strategic/ultimate objective. The phases should be a minimum of strategic and tactical planning, physical and logistical preparation, execution and follow-up.

The motif of the campaign should be nothing less than a professional image. The motif should focus on gaining the respect of all candidates and the general marketplace of human resources. The plan should always consider and reelate to the environment of the market in which it is operating. In all cases, it must consider the implications of operating in a seller's market vs. a buyer's market. Records and statistics should be kept on all phases and performance aspects of the campaign.

Finally, no methodology can survive without the active support of middle and upper management. This is especially true in the recruiting process, because personnel acquisition campaigns tend to be more effective when they have a global focus, a focus that comes from beyond that of an individual manager. In this manner, problems that cross organizational boundaries and problems that have no identified owner can be addressed in due course.

Further, they tend to be more effective when conducted as a team. Enforcement of the standards by all levels of management will help instill this character into the campaign. This in turn will reenforce consistency in the picture that is presented to the candidate.

Strategies and tactics should be key operations in whatever approach or methodology is employed because, as Dr. Y.N. Chang notes, "Strategy is one of the oldest concepts for survival in severe competition and for maximizing resources during times of scarcity ... In business, strategy plays a central role in sustaining a viable present and a promising future for the company.

"Simply stated, it is an art of general management, a game of competition and a technique of managing in times of rapid change and uncertainty ... Strategic thinking forces one to face reality, human dynamics and operational constraints. It induces one to be information-prone, data-based and analytical minded. One always explores options, strives for the optimum and executes with confidence and direction" [*The Executive*, March 1981].

These standard considerations may be adopted in whole or in part. They can be modified to accommodate the specific needs of any size of organization. Since they are considerations, most are not executable and require a method of application. They are intended as a guide in developing a methodology. In the broader sense, however, a methodology is suggested by the sequence and structure of the list.

It is important to note the standards are based on the following premises:

1) With a systematic approach, it is possible to achieve any recruiting goal.

2) Recruiting is a basic function of any business and, therefore, should be treated like any other corporate project.

3) Recruiting is a competitive process.

4) Recruiting is a decision-making process between two entities.

5) Professionals wish to identify with other professionals.

6) The recruiting process is the beginning of an employee's career with a company.

7) Recruiting and interviewing are skills that can be learned and transferred.

8) Time is of the essence during the recruting process.

9) Interviewing is basically a data gathering process for the company and the candidate.

10) Since all scientific methods and processes are not perfect, they must be modified and enhanced from time to time as environmental changes occur.

11) Observance of basics and standards over the long run will produce consistent and predictable results.

12) All involved in the recruiting process are familiar with the complete set of standards and methodology.

13) Since the employment process is the beginning of an employee's career with a company, this is where attribution minimization begins.

In the end, it does not matter what particular approach or methodology is used. What does matter is that the industry recognizes the implications and seriousness of the problem and immediately takes steps to solve it. Further, it is incumbent on the industry to assure itself that a good distribution of trained people will occur during this period of tremendous growth.

This growth can only be successfully managed through the use of standard methologies and techniques. The data processing industry must recognize where it is in its growth pattern. It is not a fully developed industry. It has just come through a period of great expansion. It is about to undergo a period of exponential growth.

By 1985 the computer industry will pull to within 17% of equaling the nation's mammoth auto industry and will probably pass it in the following year. Measured only in terms of value of hardware, if the current growth rate continues, by the mid-1990s it could be a $2 trillion industry. In just nine years, the number of technicians will probably double; by the mid-1990s, the number of people employed in the industry could exceed five million. Experience teaches us that even in a fast-growing industry, trained people are difficult to come by.

The industry's management must recognize that employment agencies and contractors alone will not solve the problem. Further, continued expansion and proliferation of the computer is assured by the current industry trend of moving the computer closer and closer to the end user.

Concurrently, the end-user community is beginning to realize the impact the computer has on the dynamics of business. For many of the positive or negative impacts perceived in the computer industry, there is a corresponding impact on the users. The user community is about to undergo a revolution in its use of and perspective on the computer.

Indeed, in many ways it has become a schema on the American way of life. The computer is no longer a convenient novelty. It has become an economic necessity. More and more we see computer hardware, programmers and analysts come under the control of the end user. This trend has created another source of demand for the experienced data processing professional. The bottom-line implication is that the competition for experienced resources will grow exponentially as demand grows.

As we move through the next two decades, the competition for resources will become keener and more sophisticated, because firms must compete for human resources — not only with processing departments, but also with the growing number of end users moving into the marketplace.

The firms that develop and practice standard methodologies and techniques will most likely survive the recruiting crunch with a minimum amount of pain. Over the next decade, the demand for people in the industry will grow by about 300%. This means the competition for the resources could also grow by 300%. The industry needs programs that will prevail over the long run.

It should be pointed out that standards and methodologies alone will not solve the problem. Whatever technique is used must be accompanied by education and training programs that prepare entry-level personnel to enter the field with a basic knowledge of it and prepare experienced people to move to other disciplines of the industry.

Until the general education facility in the country is fully prepared to do this, that burden must be supported by industry at large. Our growing pains hurt, but they need not kill us. The problem has reached critical mass. The time to begin is now.

Richmond is a vice-president with Bank of America, San Francisco, where he is in charge of administrative/financial systems and development services. ◆

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By Peter B. Wilson

BETTER PROJECT ESTIMATES FOR BETTER DECISION MAKING

If software productivity is to increase substantially in the 1980s, then software developers must gain better control of the estimating process. Technological advances in both hardware and software have led to the development of larger, costlier software systems. Unfortunately, the estimating techniques that determine which systems will be developed and which will not have not kept pace with technology.

This leads to management decisions based on poor or incomplete information and causes tremendous losses in productivity. Since most decisions relating to budgets, staffing and priorities are driven by the estimating process, more reliable estimates can yield significant productivity improvements. Research into the estimating process has typically concentrated on developing mathematical formulas based on models of the software development life cycle. However, this approach has severe limitations that probably can never be surmounted:

- To be practical, formulas must be based on only a few independent variables, but variables affecting project costs are often numerous.
- The importance of a given variable can vary widely from project to project and organization to organization.
- Technological changes can easily obsolete a model.
- The formulas cannot anticipate change or contingency with any degree of reliability.

Fortunately, the situation is not hopeless. It is the thesis of this article that significant improvements in the estimating process can be attained today. For this to occur, however, data processing management must recognize that the problems with the estimating processing are predominately management problems, not technical problems.

Better Project Estimates

Although it may appear that there are as many causes of estimating problems as there are estimates, almost all problems result from a combination of the following:

- Undefined deliverables.
- Incomplete estimates.
- Outdated estimates
- Lack of independent review.
- Lack of management understanding.

In other words, the real problems with estimating center not so much around the technology of producing a reliable estimate, but rather around the management practices that allow estimating errors to remain uncorrected and thereby to have a large impact.

In the remainder of this article, we will define what an estimate is, then discuss each of the estimating problems identified above and how straightforward management techniques can be used to pinpoint these problems early and to minimize their impact.

Fundamentally, these techniques center around integrating the estimating process into a management discipline that is based upon a well-defined project life cycle with well-defined deliverables, strict change control and effective project reporting and control.

These techniques are based upon Applied Information Development, Inc.'s (AID) project management and estimating guidelines and have been successfully used in both small and large projects for a wide variety of organizations.

What Is an Estimate?

If an estimate is to be useful to management, it must be more than a number and more than a guess as to what a project will eventually cost. To be useful, an estimate must include four components:

- Cost.
- Target dates.
- Risk.
- Assumptions.

Cost is the most obvious component of an estimate.

What is frequently less obvious is what the cost means. Unless otherwise stated, there will be a tendency for management to assume that an estimate includes "all" costs. Estimators, in turn, will tend to estimate only direct manpower costs of the project team. This potential misunderstanding can be very costly and must be avoided by clearly communicating what is and what is not included in the estimate of cost.

Target Dates

Target dates must be included with any estimate for the following reasons:

- They will be needed to judge the cost/benefit of the system.
- They will be needed to anticipate staffing requirements and to manage the project effectively.
- They will be needed to compare actual progress with estimated progress.

Risk Component

The next component of an estimate — risk — can be defined loosely as the probability that actual costs will exceed estimated costs. The greater the risk, the higher the probability. The degree and nature of the risk should be communicated with the estimate.

High risk projects warrant examination of approaches that can minimize the potential for substantial cost overruns and minimize the impact on the organization if the system is substantially delayed.

Project risk will be inreased if either:

- An estimating assumption has a high probability of being invalid.
- An invalid assumption can cause a significant cost deviation.

Because of this relationship with risk, assumptions are a critically important component of an estimate. Unfortunately, they are almost always neglected. A thorough set of estimating assumptions will include:

- A detailed description of what is being estimated. The best way to do this is to describe clearly each deliverable of the effort.
- A detailed list of project responsibilities and appropriate target dates. This list should include not only the responsibilities of the software development team, but also the responsibilities of the user, the data center and so on.
- All assumptions about the project environment such as test time, availability of test data and equipment availability.
- The degree to which the estimate allows for change (for example, scope, requirements and design changes).
- The degree to which the estimate allows for contingency.

Estimating assumptions form the foundation for the estimate. Without them, there is no basis to judge whether or not the estimate is realistic. Moreover, it becomes difficult to hold the estimator accountable for the reliability of the estimate.

Earlier in this discussion we presented the causes of estimating problems. Now that we have defined the components of a good estimate, we can discuss each of these causes and the management techniques that can be used to prevent estimating problems or at least to minimize their impact.

Undefined Deliverables

Problems are inevitable if estimates are given before deliverables are clearly understood. A typical example of this situation occurs when management wants to know how much a new system will cost before it will authorize any funding. Because the requirements for the system are not defined, the estimators really do not know what it is they are estimating.

This dilemma can be solved only by a well-defined life cycle and a phased approach to estimating. Thus, estimates must be oriented toward, and developed in detail for, only the current phase in the development life cycle.

A typical life cycle might include the following phases:

- Planning.
- Feasibility study.
- Requirements specification.
- Design.
- Development.
- Acceptance.
- Installation.
- Maintenance.

Historical data can be used to estimate total project costs after a detailed estimate is produced for a given life-cycle phase. Management must realize, however, that detailed estimates can be expected only for the current life-cycle phase; estimates for future phases (and therefore estimates for total project cost) will be subject to wide margins of error. Funding decisions should be made with this understanding. A project should be reevaluated at the beginning of each phase and funding decisions should be based on updated estimates.

Incomplete Estimates

Incomplete estimates are probably the most common and also one of the most easily prevented causes of estimating problems. Typical examples of this situation are:

- A major component of an estimate —such as risk or assumptions — was not included with the estimate. (This is especially common when estimates are communicated verbally rather than in writing.)
- Estimates that focus on programming and testing tasks and do not include adequate time for support tasks (project management, technical support) or nonsoftware deliverables (such as documentation and training).

There are two major reasons for incomplete estimates.

- A lack of understanding concerning what an estimate is and what information must be communicated by an estimate for it to be useful to management.
- A lack of understanding of the development process. The estimator may simply not recognize all the deliverables that must be produced by the effort, or the estimator may not understand the development process well enough to identify all the tasks that will be required to produce the deliverables.

Incomplete estimates can be avoided by having a clear standard regarding the content of an estimate and by having a well-defined life cycle with well-defined deliverables.

Estimating standards must require that costs, elapsed time, risk and assumptions be included with every estimate, and management should refuse to accept any estimate which

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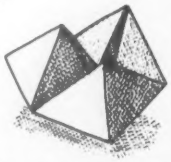

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"Unless change is controlled, it will be possible for a small simple system to become a large complex system."

does not address each area adequately.

A well-defined life cycle is a requirement for reliable estimates. It will minimize the occurrence of incomplete estimates because there will be less confusion over deliverables, their content and when they are produced. Moreover, since different projects will follow the same development steps, it becomes easier to compare and contrast varying project experience and as a result pinpoint missing or inconsistent aspects of an estimate.

Outdated Estimates

Any software development project is an ongoing activity and, as time progresses, conditions and circumstances can alter significantly. Because of this, estimates can quickly become outdated for any of the following reasons:

- Change.
- Contingency.
- Unplanned tasks.
- Inaccurate task estimates.
- Less than optimal staff productivity.

Change is an inevitable aspect of any project. In this context, we mean any circumstance that can cause a predictable change to an estimate. Change results not only from requests to modify or enhance a system, but also from situations that invalidate estimating assumptions (such as late delivery of equipment or difficulties in properly staffing a project).

Unless change is controlled, it will be possible for a small, simple system to become a large, complex system without management knowledge or approval.

The most effective solution to this problem is simply to make the cost and target date impact of any change visible to management. A formal change control procedure that requires all proposed modifications and enhancements to be estimated and approved before work commences is essential if management is to gain control of the estimating process.

To be totally effective, the procedure must also be used to formally update estimates whenever estimating assumptions prove to be invalid. Effective change control helps to separate those factors that are beyond the knowledge and control of the estimator from other causes of estimating variance. Only in this manner is it possible for management to hold the estimator accountable for his estimate.

Additional Benefits

Effective change control can provide additional benefits. If the user requests a significant number of modifications to the system, it may be an indication that the requirements are not defined well in the system specification or are not well understood by the user. If the problem lies in the specification, priority can be given to improving the specification.

If the user does not understand what the requirements of the system should be, consideration can be given to a prototype or "throw-away" system. Effective change control will provide visibility of these problems to management.

Contingency differs from change in that it cannot be anticipated. It represents lost time or effort that is reported to management after it has occurred. Hardware problems and users unavailability for scheduled meetings are examples of contingency. Contingency, like change, cannot be anticipated with any accuracy and therefore should be estimated and reported separately from individual task estimates.

Excessive contingency time typically reflects a poor development environment (such as inadequate testing resources or poor user relations). Although contingency is, by definition, not under the control of the project team, it is, to some extent, under management's control and the causes of excessive contingency should be examined. Thus, separate reporting of contingency can provide another tool that management can use to pinpoint development problems early.

Unplanned tasks and inaccurate task estimates represent problems with estimates. These problems can be largely controlled by effective independent review of estimates and periodic reestimates of tasks as part of an ongoing project reporting and control system. Less than optimal staff productivity cannot be anticipated by the estimator, but it can be brought to management's attention by an effective project control system.

Lack of Independent Review

Even good people make mistakes. Thus any estimate merits review for completeness, consistency and reasonableness. Conscientious, independent review of estimates provides two important benefits:

- Errors can be caught much earlier than would otherwise be possible.
- The knowledge that an independent review will be conducted will often cause the estimator to be more careful and thorough.

It is in this area that mathematical estimating models can be of most value. The formulas can be used to pinpoint those aspects of an estimate that should be examined in more detail. Independent review is management's best hope for detecting missing tasks and inaccurate task estimates.

Lack of Understanding

Even good estimates can be useless if management does not understand their implications. This situation frequently leads to the following types of problems:

- Management does not understand the estimating risk and therefore does not develop contingency plans to protect against serious delays or cost overruns.
- Unrealistic goals are imposed on the project team. As a result, excessive overtime is required early in the project, and more staff is assigned than the project can absorb. Productivity declines, morale deteriorates, key personnel resign and the project incurs significant cost overruns.
- The project team does not receive the resources (staff, computer time and so on) assumed by the estimate and therefore estimates are not attained.

These problems are often caused because management does not find the estimated cost or target dates acceptable. In these instances, there are several options open to management:

- Independently review the estimate to ensure its validity.
- Reduce the scope of the system.
- Develop alternate approaches that might be acceptable.

Unfortunately, management sometimes assumes that additional pressure can turn unrealistic estimates into realistic estimates. In the process, management ignores opportunities to develop alternate approaches or contingency plans that could result in substantial productivity improvements.

Even when estimates are realistic and acceptable, management frequently fails to understand that estimates are probabilistic in nature and that they must be monitored closely if they are to be attained.

Management must insist that estimates be updated on a regular basis (at least monthly) as part of routine project reporting and control activities. Only in this manner can management ensure that it will receive sufficient warning of delays and thus be able to react quickly to unforeseen events.

Conclusion

In this article, we have argued that estimating is a management problem, not a technical problem. We have briefly examined the nature of an estimate, the causes of estimating problems and the management techniques that can be used to minimize estimating problems. These techniques are not new, nor are they unique to software development. They have been used and proven in many project-oriented disciplines such as engineering and construction. Significant gains in productivity can be attained in the '80s if decision making is based on a sound understanding of the estimating process and the software development life cycle. Recognition that today's estimating problems are management problems is an important first step.

Wilson is managing consultant for quality assurance and business systems with Applied Information Development, Inc., Oak Brook, Ill. ◆

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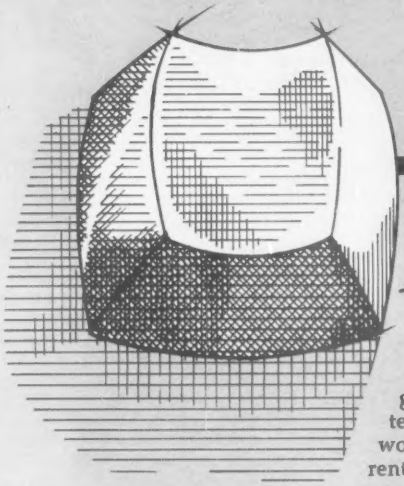


By Peter van der Linden

ADA

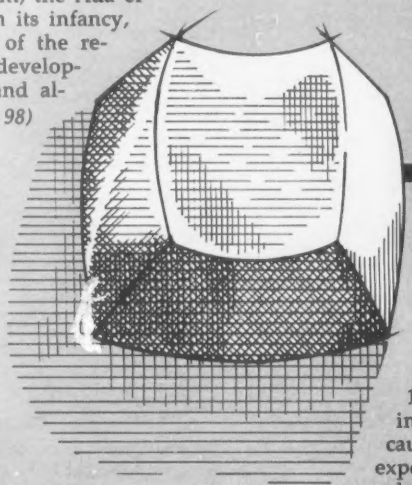
Most people in the computer business will have heard of the latest state-of-the-art programming language to be announced. Known as Ada, it is named after Ada Lovelace, who is claimed to have been the world's first programmer. Ada thus follows the current fashionable trend for naming a programming language in honor of a favorite hero or heroine. Other examples include Euler, Pascal, Edison and Euclid.

But why is there so much interest in this language, and who initiated the work on it? How does Ada compare with Cobol? This article takes a look at some of the answers to these questions.

There is little doubt that Ada will eventually become a very important and widespread programming language and may perhaps even replace Cobol and Fortran altogether. This scrapping of Cobol may well happen in response to market pressures, even though the sponsors of Ada have specifically excluded it from their list of intentions.

At present, the Ada effort is in its infancy, so most of the recent developments, and al-

(See Page 98)



By Edward G. Nilges

PL/I

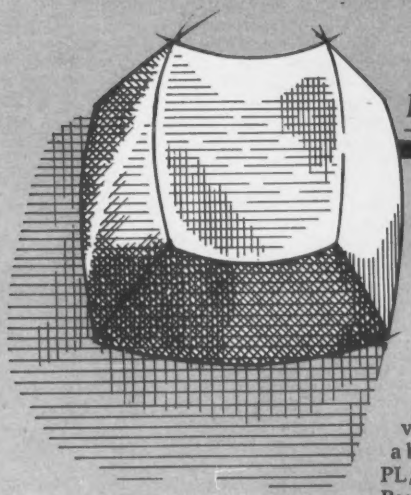
Since the introduction of structured programming and structured design in the mid-1970s, installations are again finding increases in software productivity difficult to come by. Because of compatibility worries and disappointing experiences in the past, use of newer languages such as PL/I is rarely considered. This is a sensitive issue, frequently debated by technical people.

This article will look at PL/I primarily from the manager's viewpoint. Following a look at the software manager's problems, we'll assess the costs and benefits of adopting PL/I over Cobol. Finally, the use of a training and standards program during the introduction of PL/I will be examined; such a program, we'll see, is essential to a successful conversion to PL/I.

The widely held view that PL/I is more advanced than Cobol is lost on the manager facing either the decision to use PL/I from the start or to convert from Cobol development to PL/I (thereby having to convert or continue to maintain an inventory of Cobol programs). Managers will worry instead about the following:

(See Page 104)

TO COBOL:



By Harry Katzan Jr.

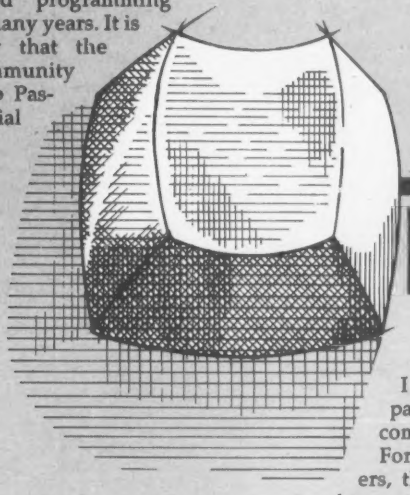
PASCAL

Pascal is in the news these days as a programming language that increases programmer productivity, contributes to overall software reliability and provides operational efficiency. But how does it stack up in a business environment? Will it replace Cobol? Is it what PL/I should have been?

Pascal was proposed and developed in the academic community, and without the support of that large, enthusiastic and often impetuous group, Pascal would not be around today. Pascal was designed by Niklaus Wirth at the Eidgenossische Technische Hochschule (ETH) in Zurich, Switzerland, and the first Pascal computer was developed there by Urs Ammann and co-workers.

For a language designed in 1968, one would assume that the language was slow in taking hold — at least compared with other languages in its class such as PL/I and Ada. In this case, however, looks are deceiving, because Pascal has been widely used in universities to teach "good" programming practices for many years. It is only recently that the business community has picked up Pascal as a potential

(See Page 109)



By Jacqueline A. Stewart

BASIC

Of the myriad computer languages available today, one of the most popular in use is Cobol. I have found that, among the Fortune 500 companies, it dominates the world of large-scale commercial applications.

For smaller operations and personal computer users, the most frequent choice for a programming language is Basic. Fortunately, there is a place for both in the business community, with one not necessarily outperforming the other.

A computer executes instructions only when they are presented in a machine language. A programmer codes symbolic instructions that are translated via a compiler or an interpreter —depending on the high-level language used — into the native code of the host computer. Subroutines are routines arranged so that control may be transferred to them from a master routine and, when processing is completed, return control to the master routine.

Compilers, as appropriate, supply the linkage that combines the subroutines into a workable routine and translate the subroutines and linkage into machine language. This compiled

(See Page 116)

Alternatives to Cobol: ADA

```
COBOL:
        01   check-amount   PIC   $**,**9.99.
        01   month-name    redefines check-amount    PIC X(10).
                                    :
                                    :
             MOVE 100.25 TO check-amount.
             DISPLAY check-amount.

           this would print out    $**100.25


ADA:  No equivalent exists as a basic operation in the language. The identical
      effect can be obtained by writing a COBOL MOVE package, and then
      invoking it so:
                :
           USE cobol_move-package;
           BEGIN
                cobol-move(100.25, check_amount);
                PUT(check_amount);
           END;

           this would print out    $**100.25
```

Figure 1: Data Manipulation

(Continued from Page 96)

most of the publicity and work has focused on the compiler writing.

However, this is just one aspect of Ada; the language was originally designed with an entire surrounding environment in mind. A description of this background and a comparison with Cobol will follow, but first, some background on the history of Ada.

About six years ago, it became obvious to the U.S. Department of Defense (DOD) that its computer application efforts were being hampered by the software crisis it shares with the rest of the world. They decided to embark on a course of action that would be available to few, if any, other computer users in the world: An official U.S. Department of Defense project was initiated with the aim of establishing a single high-level language to replace the multitude of languages they were using at that time.

Readers with long memories may recall that, back in 1957, Cobol was originally born in just such a way at the initiative of the U.S. Navy.

The ambitious Ada project began in 1975 and involved a number of intermediate stages. The DOD started by examining their computing applications and then issuing successively more definite statements of their requirements. By June 1978, the technical requirements had reached final form and were issued as the Steelman Report.

More than 25 companies bid for the contract to supply a programming language that would fulfill the Steelman requirements. Most of the major computer manufacturers in the world were represented, and in June 1979 the green language from CII-Honeywell-Bull was officially adopted. The language was renamed Ada in honor of Ada Lovelace, who worked with Charles Babbage on his Difference Engine and who was a 19th-century English pioneer of some of the concepts of modern software engineering.

Ada Environment

In view of the overwhelming attention paid to Ada language compilers, it might seem these form the central effort of the original DOD project. This is not entirely the case. As the emphasis shifts from the language design to its introduction and use, its environment will become more important. In fact, every host installation where Ada programs are developed is supposed to support an Ada environment.

There is no real counterpart of the Ada environment in Cobol. This is unfortunate for Cobol because programming environments will be accepted more and more over the coming years and will be recognized as invaluable. A programming environment can be many things, but is usually taken to mean a set of sophisticated, integrated software tools that greatly speed up program development and maintenance.

It is envisaged that the Ada environment will be similar to, say, the APL programming environment or the Interlisp programming environment. The programmer is supplied with all the modern tools and never leaves his Adalike surroundings to venture into the world of the cruel vagaries of the real machine supporting him.

An integrated data base will exist on the computer to cushion and assist him. The information in the data base will not be about sales, products or salaries — it will concern programs, packages and modules. It is intended to be used by both programmers and management in the ordinary course of their work.

This data base, together with its interface to the host system and the other programmer tools (editor, debugger, link-loader, pretty-printer and so on) has been termed the Ada Programming Support Environment (Apse).

Systems like these really assist programmers by providing very powerful editors and other tools that are perhaps linked to and integrated with each other. They make it possible to get the computer to do more of the menial repetitive or time-consuming tasks, and they can significantly boost programmer productivity. Programming environments (as these systems are termed) will be a particularly important factor in reducing or resolving the software crisis in the years to come.

Older, more traditional languages such as PL/I, Cobol, Basic and Fortran, which currently enjoy widespread usage, will eventually become simply too expensive to use, when compared with languages using newer technology. After their cost-effectiveness has come into doubt, these older programming languages will be replaced, just as they in their time supplanted languages such as Comit and Flow-Matic, which are now regarded as obsolete.

Although programming environments are not uniquely applicable to the Ada effort, this language is an appropriate vehicle for testing them and developing them past their current embryonic state.

Furthermore, the Ada language has been designed with its environment in mind; it is integrated and central to the theme of the language. It would not be easy to provide a similar high-quality environment for Cobol, which already suffers from a surfeit of added-on extras: the structured programming features, the data base module, the ANS 1974 changes, the teleprocessing module, the expected ANS 1982 changes and so on.

Ada Compilers

Some of the foremost computer science institutions in the world have devoted their attention to producing a compiler for Ada. Compilers are under development by a number of organizations: Stanford University, Carnegie-Mellon University, University of Karlsruhe (West Germany), the Courant Institute, Intermetrics, Inc., Intel Corp., Softech and others.

However, either their implementations are not yet finished or some aspects of the language have been left out. If there has been such a great deal of work on this programming language, why is there no complete compiler for it yet?

There are several answers to this question — most hinging on the size of Ada and the number of innovations it introduces.

Ada is actually a very large programming language, much larger than Cobol and almost comparable to PL/I in size, but fortunately not in

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"Until a good Ada 'cobol-move' package is written, Cobol will remain the preferred language for the business domain."

enigmatic baroqueness. For example, some compiler writers, such as myself, are using Yacc (which is a parser generator tool) to assist in building one part of the compiler.

Yacc comes in three flavors: small, medium and huge. Even the huge size is not sufficiently capacious to deal with the Ada grammar. The Yacc at Yale University, where I am carrying out some work on Ada, now comes in four sizes: small, medium, huge and heADAche! It was this kind of grossness that led C.A.R. Hoare to remark that "Algol-60 was a significant improvement over almost all of its successors!"

The size of Ada and its resemblance to a kind of infant PL/II has caused sharp criticism from some computer scientists. The difficulties arising from the sheer size of the language will be initially reflected throughout: in the slowness and size of the compilers, in the slowness and size of the object code produced, in the complexity of the translators and so on.

Nonetheless, these are mostly problems facing implementors and systems programmers, rather than applications programmers who will actually make productive use of the language. Anticipated advances in hardware may also somewhat mitigate these problems.

The Nitty-Gritty

How does Ada shape up when compared to Cobol? Programming languages are often categorized by their two main aspects: control statement facilities and data-structuring facilities. Or, in Cobol terms, the procedure division verbs and the data division entries.

Traditionally, Cobol has always been weak in the former and much stronger in the latter. This has been tolerable because, in business structured programming terms, we recognize that data objects (rather than operations on them) form the primary focus of our interest. Ada has been designed with both control statements and data structuring abilities equally in mind.

Cobol is undeniably a very capable language in the limited field of file, text and digit manipulation. If you require a 10-digit field which holds two decimal places, puts commas every three digits, inserts check-protection asterisks, but may also occasionally contain the name of a month, this is no problem in Cobol. You can define exactly that in a very simple straightforward way (see Figure 1 on Page 98).

There are many data processing problems that call for exactly this sort of manipulation and nothing more, and Cobol was tailor-made for these. Ada has no in-built operations that can carry out these useful transformations. They can be simulated by procedures, but that would imply a certain runtime overhead. However, the Cobol form usually translates directly into one or two machine instructions.

Until a good Ada "cobol-move" package is written, Cobol will remain the preferred language for the business domain. However, there are also a great many data processing problems that require more sophisticated computing. Anyone who has had to write a Cobol program of more than 1,500 lines will have a warm understanding of this point.

The fact is that programming language technology has moved on since 1957 (Cobol and Fortran), since 1965 (PL/I and Basic) and even since 1973 (Pascal). We now have a better grasp of what it is feasible to instruct computers to do and a better grasp of how to represent these instructions in a programming language.

For example, the Cobol IF statement has sometimes been a source of obscure program bugs when deeply nested. Some installations have rules forbidding more than a specified level of nesting (often zero). None of this is necessary in Ada, since the CASE statement can often be used instead (see Figure 2). Not only is this simpler to read and write, but it also avoids nesting and is easier and quicker to comprehend. The whole of the Ada language has been designed with a careful attention to orthogonality, regularity and (it is claimed) simplicity.

In addition to this clean handling of verbs, Ada has many, many fea-

```
COBOL:
process-code.
                IF   code = 'a'
                THEN   PERFORM process-a-code
                       GOTO finished-code
                ELSE   IF code = 'b' OR 'c'
                       THEN   PERFORM process-bc-code
                              GOTO finished-code
                       ELSE   IF code = 'd'
                THEN   PERFORM process-d-code
                       GOTO finished-code
                PERFORM process-unknown-code.
finished-code.


ADA:
      CASE code IS
  WHEN 'a'                  => process_a_code;
  WHEN 'b' | 'c'            => process_bc_code;
  WHEN 'd'                  => process_d_code;
  WHEN others               => process_unknown_code;
END CASE;
```

Figure 2: Cobol nested-IF vs. Ada CASE statement. Which of these two equivalent statements do you think is simpler to follow?

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Alternatives to Cobol: ADA

tures that are not present in Cobol at all. Some of these are straightforward in nature, like the rigorous standardization that will be applied to Ada. The Department of Defense is not recognizing any subsets of the language and proposes to check out or "validate'" each Ada compiler before permitting it to be used.

The basic idea is to feed a candidate compiler with hundreds of awkward test case programs to try to find any deviation from the language standard. In an attempt to obtain maximum portability, it has been decided to check Ada compilers not only for features left out, but also to make sure that no extra features have been inserted. Subset validation is already done for Cobol compilers at the Federal Compiler Testing Center, but superset checking (i.e., no extra features) is a valuable new idea that will greatly assist software portability.

One of the most important features of Ada, and one that Cobol does not have, is its separate compilation ability. This is refined to the level where procedure division SECTIONs (in Cobol terms) can be compiled independently and brought together only at link-load time. Obviously, this will speed up program development by permitting different programmers to work on different parts of one module, localize maintenance and reduce compilation time.

Ada has a series of other very powerful constructs that assist the construction of very large programs consisting of many modules. In contrast, Cobol has a weak and clumsy method of modularization and interprogram communication.

A key idea in Ada is that of packaging. Packaging is the term applied to bundling up a subprogram together with all the data structures it operates on and then presenting this as a "black-box" that is available to other modules as a unit, and only through a strictly-defined interface. Readers who have found almost untraceable bugs in COMMON-STORAGE SECTIONs or LINKAGE SECTIONs will appreciate the merit of packaging.

It is envisaged that packages will be written to support any features that are found useful in Ada, but that are not part of the language. For example, the cobol-move statement could be supported as an Ada package. Sorting and merging are also operations that are good candidates for packaging. The rigorous standardization of the language ensures that once a package has been written, it will be good for all installations on all hardware with minimal changes. This constitutes a tremendous advantage present in few, if any, other programming languages.

The Way Forward

There are a great many other features that Ada contains, but they are probably of more relevance to systems programmers or real-time programmers than to the general business data community. Tasking (control of parallel processes), generics (macrolike facility) and access types (pointer variables) probably come into this class.

Cobol was designed more than 20 years ago to serve the needs of the commercial computer user. Ada was designed to fulfill the DOD's need for a real-time programming language for dedicated processors; the result is sufficiently general-purpose that Ada can do the job of many specialized languages, usually better.

Some influential voices in the computer science world have predicted Ada will have replaced Fortran by the mid-1990s. Certainly there can be little doubt Ada will eventually supersede that language within its sphere of application.

The areas where Ada will be used initially are quite limited, solely in embedded computer systems. It is likely the use of Ada will very quickly become much more widespread after this initial foothold has been established. Certainly Ada will quickly gain large-scale acceptance outside the military domain.

The timeframe in which this domination takes place may be longer than 15 years, but it is bound to happen eventually simply because of the vast commitment the DOD has made to Ada, backed up in terms computer businessmen understand: hard cash.

In fact, so much faith has been placed in the success of Ada that one major semiconductor manufacturer has been inspired to declare its latest product is an "Ada engine," meaning the hardware is particularly suitable for executing that language.

Ada is here to stay. The question is, "Will this be the demise of Cobol?"

Van der Linden is pursuing a graduate degree at the Computer Science Department of Yale University. Previously he did independent consulting work in Cobol in the UK.

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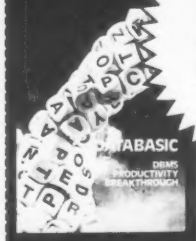

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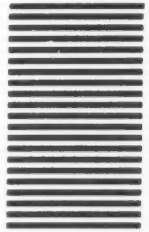

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Alternatives to Cobol: PL/I

(Continued from Page 96)

- Productivity in development.
- Productivity in maintenance.
- Getting adequate programming help.
- Minimizing disruption.

Productivity in development and maintenance is clearly most important. Most managers find that if the right problem is being solved, a smooth and productive development stage results in a highly maintainable system. For this reason, the language adopted must facilitate program development.

However, none of the available high-level languages ensure that programs will be easy to maintain. Fortran, Cobol, PL/I and others have as a goal enabling the programmer to write many kinds of programs, including pathological programs. In the absence of good training and standards, the manager may be sure that pathological programs will be written.

Since adequate programming help must be available, the manager must have an idea of what potential employees will know before deciding on a standard language. Two practices exist:

- Some companies hire inexperienced programmers with computer science degrees and promote largely from within. These companies have to know what is taught in the schools.
- Many companies fill their ranks with experienced programmers; managers at these firms have to take into account languages used by nearby companies.

Finally, the manager hopes to minimize negative disruption, even where productivity would be served by drastic steps. A period of crisis may hurt long-term goals.

PL/I: Costs and Benefits

In view of the manager's concerns, what are the costs of using PL/I in place of Cobol?

- PL/I can be hard to learn.
- Poorly-written PL/I can be very cryptic because of the heavy use of operators and nested constructs in this language.
- PL/I programming help may be difficult to find.

The size of PL/I discourages the student. One of the design objectives of PL/I's original developers was to minimize the need to learn all of its features by incorporating default values for choices the programmer did not know enough to make.

This objective has not been attained. The PL/I designers forgot that the absence of a decision is still a decision.

Today, a mark of the good PL/I programmer is that he or she knows what should be explicitly declared. This can come only from hard experience or a good training and standards program.

Another difficulty programmers face in learning PL/I lies in PL/I's conversions. Although PL/I gives the programmer a lot of freedom in mixing variables of different types in expressions, the rules for the type of the resulting expressions are complex and difficult to master. Programmers who understand machine-level data representation sometimes have difficulty remembering that PL/I won't allow direct access to data as it is stored. The UNSPEC function must be used to get the machine-level bit string corresponding to a nonbit data item in this language.

Both PL/I and Cobol can be written in an unreadable fashion (see Figure 1). PL/I's added richness and its heavy use of operators in place of English words makes bad PL/I code even less readable than bad Cobol code.

PL/I help will be hard to find when hiring focuses on experienced people in a geographical area where Cobol is usually an installation standard. This will be less of a problem when the company hires trainees and promotes from within. If the trainees come from four-year computer science programs, they may have been exposed to PL/I or languages similar to PL/I (such as Pascal).

What benefits are to be had from using PL/I?

- PL/I supports structured programming and structured design.
- PL/I provides many ways to get desired results (richness of function).
- PL/I supports packaged procedures and included modules better than Cobol.

It is possible to write structured programs in Cobol. However, PL/I provides a more direct way of implementing a structured system. It does this in two ways, at the coding level and at the design level.

With the exception of the CASE

COBOL	PL/I
IF A GREATER THAN B IF C LESS THAN A IF SWITCH-ON OR COME-BACK-HERE PERFORM GLUMPH IF DD EQUALS DDD GO TO TIMBUKTU ELSE GO TO KABIBBLE ELSE IF DDD EQUALS DD AND COME-BACK-HERE CALL 'CANCEL' ELSE NEXT SENTENCE ELSE GO TO NERTS-KABIBBLE.	A=SUBSTR (UNSPEC(SUBSTR(A,1,5)), MIN (A,B))

Figure 1. Heavily-nested PL/I and Cobol code (not good practice).

STRUCTURE PROGRAMMING CONSTRUCTS	COBOL PROGRAMMING	PL/I PROGRAMMING
execute	ADD, SUBTRACT, MOVE, READ, ETC.	Assignment, GET, PUT, CALL, etc.
if. . .then. . else	IF condition (THEN actions) ELSE (ELSE actions)	IF condition THEN DO; (THEN actions) END; ELSE DO; (ELSE actions) END;
do while	PERFORM LOOP-BODY UNTIL not condition. . . LOOP-BODY. (loop actions)	DO WHILE condition; (loop actions) END;
do until	PERFORM LOOP-BODY. PERFORM LOOP-BODY. UNTIL condition. . . LOOP-BODY. (loop actions)	DO UNTIL condition; (loop actions) END;
case	GO TO CASE-1 CASE-2 . . . CASE-n DEPENDING ON variable	IF variable=case¹ THEN DO; (case¹ actions) END; IF variable=case² THEN DO: (case² actions) END; . . .

Figure 2. Structured style in PL/I and Cobol.

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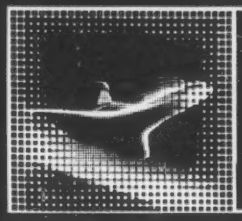

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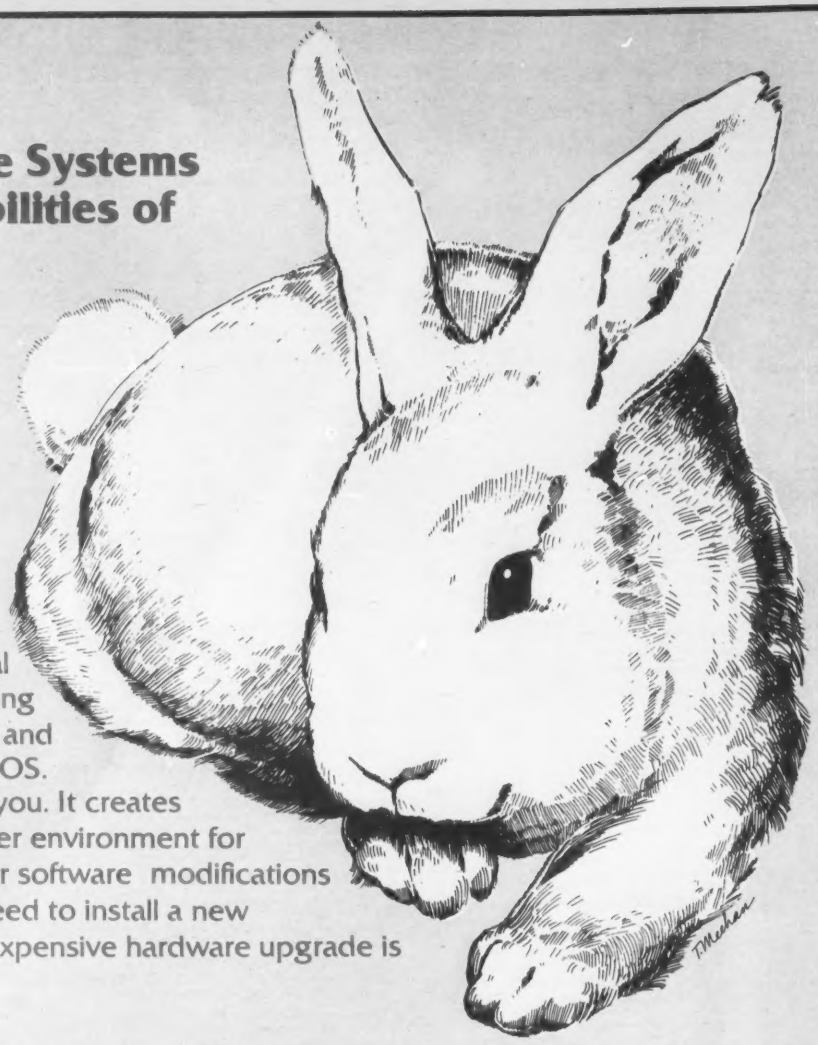

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statement, the basic and enhanced structured constructs are supported directly in PL/I. Cobol programmers can model these constructs, as shown in Figure 2 on Page 104. But PL/I's support for most structured constructs provides these advantages.

- Code review is simplified. One user of PL/I said that since both managers and technicians know pseudocode, PL/I that is written like pseudocode is more accessible. This readability was an unrealized hope of the Cobol developers.
- Nonproductive debate among the technical staff about how to use Cobol in support of structured programming is eliminated.
- Highly individual approaches to writing structured Cobol are minimized.

These advantages accrue because using Cobol to implement pseudocoding constructs involves coding around Cobol's limitations.

Some of these Cobol problems are being addressed by Codasyl and Ansi. The new proposed Cobol standard includes END-IF, which will probably see general implementation in a few years. Also, note that a Cobol loop with an object other than a single PERFORM may be implemented. Note that PL/I has these features now.

Also, without good training, programmers tend to ignore new features in the rush to get the job done. This happened with the STRING and UNSTRING verbs, introduced with the Cobol-74 standard. I fear that this may happen to the structured additions planned for Cobol.

PL/I supports structured design by enabling locality of reference. Cobol programs have large Data Divisions; any data item can be changed by any Procedure Division statement. While it is possible untrained ex-Cobol programmers will structure their PL/I code in the same way as a Cobol program, PL/I provides the ability to write small internal procedures with data declarations at the beginning, thereby restricting access to this data.

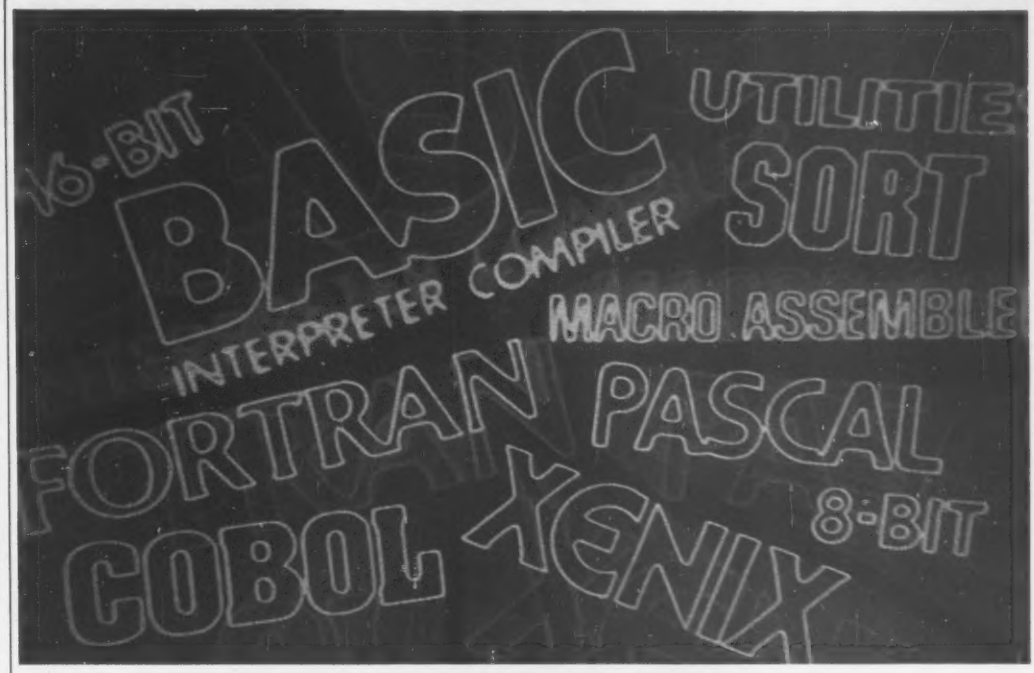
Many programmers will disagree with this writer about richness of function as a benefit. PL/I's range of features has often been misused.

But nowadays the day-to-day reality of programming in shops with a reasonable amount of discipline does not involve pathological misuse of facilities. The industrial shop is instead plagued by the need to continually reinvent the wheel, generating many lines of code that in PL/I can be implemented by a function call.

Cobol's lack of a good facility for subroutine definition and packaging also results in continual reinvention of the wheel. The COPY statement cannot be freely used (although it has been cleaned up in the 1974 Cobol standard). Cobol subroutines are implemented either by external PERFORM paragraphs placed into source code or the CALL statement. External PERFORM paragraphs are seldom used because they have to refer to fixed, nonlocal data areas. Cobol subroutines provide call-by-reference exclusively (it's not valid to code CALL "A" USING 1). All Cobol red tape (such as the ENVIRONMENT division) has to go into the subroutine.

Both subroutines (procedures) and functions are supported in PL/I. An %INCLUDE capability allows library code or data to be embedded wherever a statement is valid.

A sure way to maximize the negative impact of adopting PL/I is to neglect a training program or the development of a standards manual.



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Alternatives to Cobol: PL/I

The training course should not attempt to exhaustively cover all PL/I features. Instead, it should teach good, standard PL/I style.

The course will be far more important than the standards manual. The standards manual is not unnecessary; it serves as a court of final appeal and will educate those programmers who would rather read than listen.

Standards imparted will be of two types: syntax and semantics.

Syntax standards are easily enforced. They have to do with the form of the program and are usually "don'ts." The major syntax standards fall into four types:

- Subsetting, in which programmers are restricted to a part of PL/I's facilities.
- Structured code, in which GOTO or excessive ON-units are prohibited.
- Data naming conventions: descriptive names should be enforced; each name should have a short prefix uniquely identifying the procedures which declares it. Redeclaration of names (procedure A declares 1; A calls B, which also declares 1) should be prohibited.

Semantic standards have to do with the way in which the program runs; conformity with them is hard to check. However, semantic standards benefit productivity to a greater extent than syntax standards. Here are some useful semantic standards:

- Modular style.
- Correct use of storage classes.
- Preparation for debugging.

In modular PL/I style, these rules apply:

- Modules should be short and straightforward.
- Ideally all procedures defined should be external (separately compiled). This forces good definition of interfaces and simplifies maintenance in that only changed procedures have to be recompiled. When internal procedures are necessary, they should be nested within the procedure that CALLs them (if they are CALLed by only one procedure).

Use of storage classes should be guided. Current IBM PL/I compilers provide efficient ways for allocating AUTOMATIC variables, which get storage at the point of declaration and lose storage when their declaring procedure releases control. Although new PL/I programmers will sometimes forget that the contents of an AUTOMATIC item are lost when control returns to its declaring procedure, AUTOMATIC storage imposes a lighter load on virtual storage paging mechanisms.

CONTROLLED and BASED storage is useful at times. CONTROLLED storage areas can be varied in size depending on conditions when the program runs. BASED storage is useful chiefly in I/O and list processing.

Ex-Cobol programmers may overuse STATIC storage allocation, since Cobol provides the same sort of capability (data gets storage when the program is loaded). But STATIC storage in a big program will impose an extra load on virtual storage paging mechanisms.

Attention should be paid to debugging. PL/I generates extra run time processing and data that make PL/I dumps hard to read.

PL/I debugging must be planned in advance. Good style and code reading is important. And one of the best debugging tools consists in providing extra output:

- Messages indicating program progress can be added and removed before production. The problem with these messages is that often programmers don't add them until there seems to be a problem.
- Good report design with cross-footing fields makes life easier for debugger and end user. Error checks and English messages when things go wrong catch errors in test data and unexpected situations in live data.
- Control totals (records in/out, exceptions please auditors as well as help debugging.

We have evaluated PL/I's costs and benefits, and looked at the training and standards program that must accompany PL/I. In many elegant ways, PL/I is more advanced than Cobol. However, the marginal impact of some of these features means that large shops, heavily committed to Cobol, will not profit by converting to PL/I. The problems in converting to PL/I and in finding PL/I help will be accompanied by ongoing problems in maintaining the inventory of old Cobol programs.

New shops, small shops with few old Cobol programs, multilanguage shops and shops doing scientific and engineering applications extensively should choose PL/I over Cobol. But good training and standards are essential in maximizing the benefits of this language.

Nilges is a consultant with Chicago-based SEI Information Technology. ◆

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Alternatives to Cobol: PASCAL

(Continued from Page 97)

means of increasing programmer productivity.

One of the key attributes of Pascal is its simple and consistent language structure. But these characteristics, which provide the means for software reliability and programmer productivity, also indirectly serve to reduce the problem domain of Pascal.

Some of the obvious limitations that are commonly regarded as areas for possible extensions are direct access and file handling, storage management, tasking, communications and data base. For sure, the procedural facility in Pascal permits a programmer "to write his own," but severely limits the portability of Pascal programs. Regardless of the eventual outcome of the extensions question, Pascal should provide a bright future for the business community.

The key to the effectiveness of Pascal as a programming tool is the existence of a well-defined structure for Pascal programs. (A program unit in Pascal is known as a block.)

While other languages also require a structure, the requirements for Pascal are a bit more rigorous than most. In fact, all declarations and definitions must be placed up front in Pascal and every variable must be declared. This requirement, known as strong typing, contributes to software reliability, ease of maintenance and compiler efficiency.

A simple example of a Pascal program is given in Figure 1. (While Pascal does not distinguish between uppercase and lowercase letters, uppercase letters in this article denote words supplied by Pasca! while lowercase letters denote user-defined words.)

In this example, the structure of the program is practically self-evident. PROGRAM denotes the program heading and VAR signifies the variable declarations. BEGIN indicates the start of the block and END is the block terminator. Every Pascal word is not covered here, but the rule given above will help the reader distinguish between the two.

Ironically, the structure of a Pascal program agrees quite nicely with the ID, ENVIRONMENT, DATA and PROCEDURE divisions of a Cobol program.

Four basic data types are built into the Pascal language: integer, real, Boolean and character. However, Pascal permits new forms of data to be defined, allowing information to be defined meaningfully for a given application. New data types build upon three important Pascal concepts: enumerated data, defined data and subrange data.

- **Enumerated Data.**

In the enumerated data type, values are listed in order, as in the following variable declaration:

```
VAR
   weekday:
      (mon,tue,wed,thr,fri);
```

Thus, weekday is the name of a variable that can be assigned one of the values from the given list. Each enumerated data value is an identifier with no explicit external correspondence. This simply means that enumerated data values cannot be read in or written out.

Enumerated values have an order that extends from left to right. Given the variable declaration:

```
VAR
   jimcar:
      (chevrolet,pontiac,buick,oldsmobile,
      cadillac);
```

then the comparison expression:

```
pontiac < cadillac
```

would have a true value. The same scalar value can be assigned to more than one variable. Thus, for the declaration:

```
VAR
   firstcar,
   secondcar:
      (chevrolet,pontiac,buick,
      oldsmobile,cadillac);
```

the following assignment statement would be valid:

```
firstcar := oldsmobile;
secondcar := chevrolet
```

An enumerated data value is not the same as a condition-name in Cobol, such as:

```
05 YEAR-IN-SCHOOL
      PICTURE 99.
   88 PRIMARY-SCHOOL
      VALUES ARE 1 THRU 6.
   88 JUNIOR-HIGH
      VALUES ARE 7 THRU 9,
   88 HIGH-SCHOOL
      VALUES ARE 10 THRU 12.
```

whereby the Cobol programmer can use a condition-name, as in:

```
IF JUNIOR-HIGH . . .
```

to simplify writing the conditional expression:

```
YEAR-IN-SCHOOL NOT <<7
AND YEAR-IN-SCHOOL NOT <<9
```

Instead, enumerated data in Pascal are designed to encourage readability and enhance program correctness.

Figure 2, for example, gives a program segment that associates a meaningful identifier, such as ≪mon≫ for the day Monday, with an integer value, such as the value 1 in this case. As a result, a programmer could then write:

```
IF dayname = mon . . .
```

```
PROGRAM mpgcalc(INPUT,OUTPUT);
   VAR miles,
       gals,
       mpg:
          REAL;
   BEGIN
      READ(miles,gals);
      mpg := miles/gals;
      WRITELN('miles per gallon:',mpg)
   END.
```

Figure 1. Example of a Pascal program. (The structure of the program is evident and is enhanced through indentation used to promote readability.)

```
VAR
   day:
      1 .. 7;
   dayname:
      (mon,tue,wed,thr,fri,sat,sun);
   .
   .
   .
   READ(day);
   CASE day OF
      1: dayname := mon;
      2: dayname := tue;
      3: dayname := wed;
      4: dayname := thr;
      5: dayname := fri;
      6: dayname := sat;
      7: dayname := sun;
   END
```

Figure 2. A program segment that associates a meaningful name with a numeric value.

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Alternatives to Cobol: PASCAL

instead of

```
IF day=7 . . .
```

While the use of enumerated data may appear to be trivial — at least at first glance — its overall impact on program correctness could obviously be quite large. Moreover, the use of enumerated data facilitates effective structured walkthroughs, which are another means of enhancing software reliability.

• **Defined Data.**

Standard data types represent four classes of data that are used frequently enough to warrant special considerations and, as presented thus far, enumerated types would appear to apply to situations wherein variables with special values are required. The two underlying philosophies are combined by allowing the Pascal user to define a data type literally, and then subsequently use that definition with other type definitions and with variable declarations.

An example of a type definition is:

```
TYPE
  day = (sun,mon,tues,weds,thurs,fri,sat);
```

It may be used in a subsequent variable declaration in the same procedure as follows:

```
VAR
  delivery:
    day;
```

This is precisely the same as though the user had written:

```
VAR
  delivery:
    (sun,mon,tues,weds,thurs,fri,sat);
```

In fact, the standard type Boolean is an enumerated data type, implicitly defined as:

```
TYPE
  Boolean = (false,true);
```

and the relationship between values is that false is less than true. Since Boolean is a standard data type, there is no need to define it. If it were defined, however, it would take the form given above.

Referring again to an additional example of a type definition, such as:

```
TYPE
  taskstatus = (ready,active,pagewait,
  iowait);
```

we can say that a variable of type taskstatus can be assigned one of the following values: ready, active, pagewait or iowait. Conversely, we can say, for example, that ready is a value of type taskstatus.

• **Subrange Data.**

A subrange is a subset of a standard data type or of a previously defined type. The values represented by a subrange are a restricted set of values, as in:

```
VAR
  year:
    1980 . . 1987;
```

This declaration specifies that ≪year≫ is an integer variable that may only be assigned integer values that range from 1980 to 1987. The values are interpreted as a subrange because the lower and upper bounds are specified as constants and they are both instances of a recognized data type. Similarly, the following:

```
VAR
  suffix:
    'A' . . 'Z';
```

defines a character subrange that

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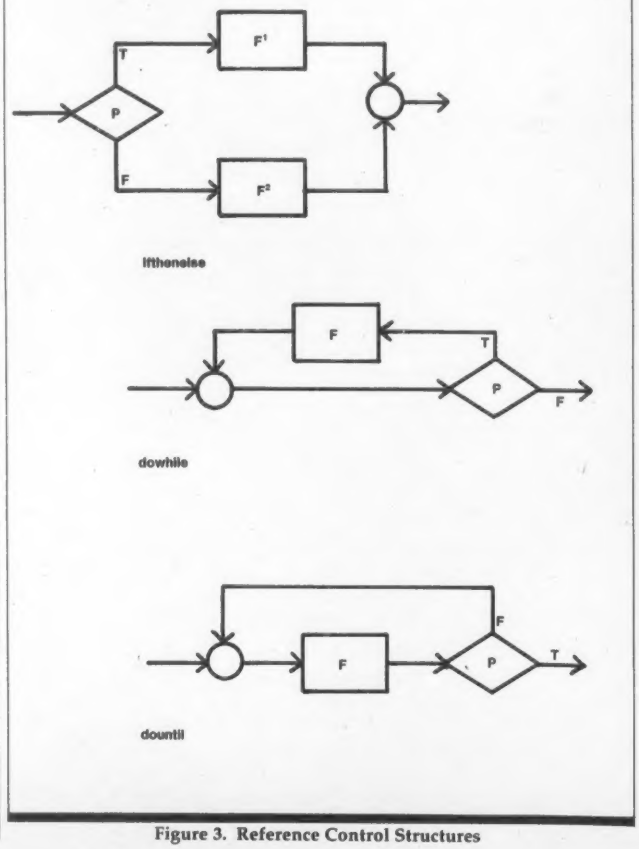

Figure 3. Reference Control Structures

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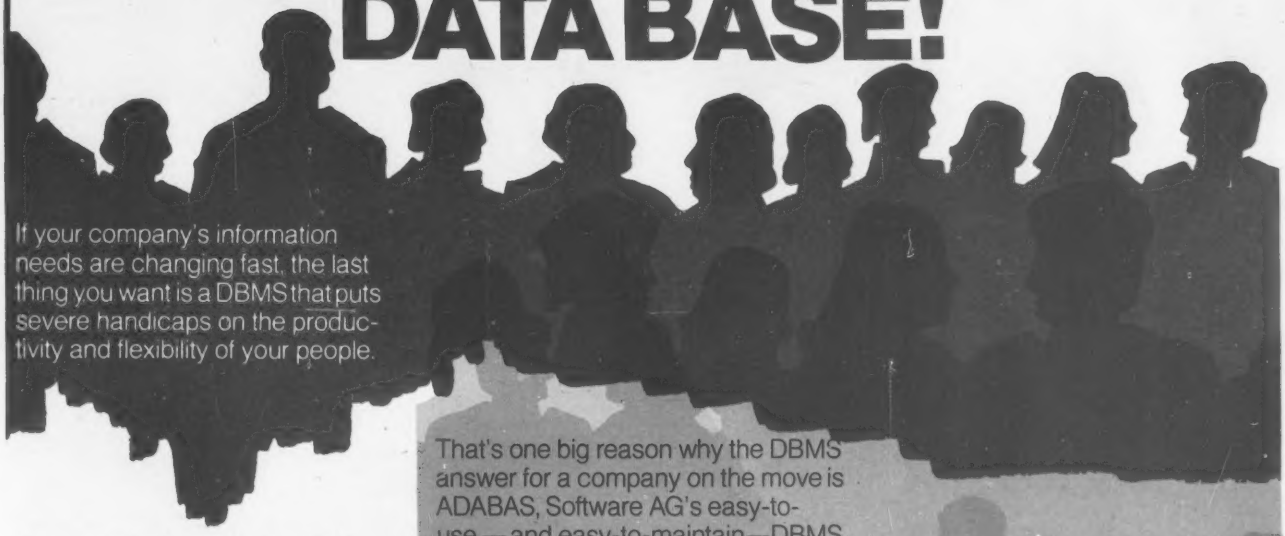

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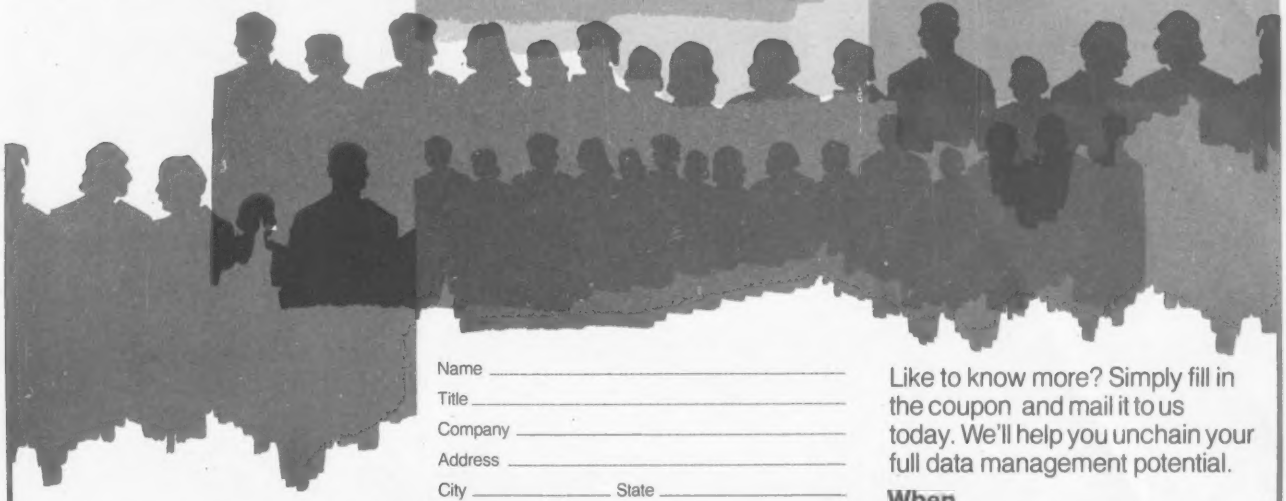

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Alternatives to Cobol: PASCAL

spans the letters 'A' through 'Z'. The key advantage of using a subrange over its underlying data type occurs when an attempt is made to execute an assignment statement wherein the value to be assigned is outside the specified range. When this occurs, a runtime error condition is invoked. Figure 2 contains a subrange specification in the declaration of the variable ≪day≫.

The notion of a subrange applies to enumerated data as well as to integer and character data. The following statements define subranges based on enumerated types:

```
TYPE
   day =
      (sun,mon,tue,wed,thurs,fri,sat);
   month =
      (jan,feb,mar,apr,may,jun,jul,aug,
      sep,oct,nov,dec);
VAR
   workday:
      mon . . fri;
   summer:
      jun . . aug;
```

In the latter examples, it was permissible to define the subranges because the various types were established beforehand.

When a data processing application involves several items of data that are of the same type and relate to the same group of computations, it is customary to organize the data items as a table and use a subscript to select an item in the table. In Cobol, for example, a production table might be declared as follows:

```
01 PROD-DATA.
   02 PROD-LIST PICTURE 9(5) OCCURS 12
   TIMES.
```

which is an array composed of 12 elements — one for each month. In this example, PROD-LIST (1) would refer to January production, PROD-LIST (2) would refer to February production and so forth. In Pascal, an equivalent table could be declared as:

```
TYPE
   month =
      (jan,feb,mar,apr,may,jun,jul,aug,
      sep,oct,nov,dec);
VAR
   prodlist:
      ARRAY[month] OF INTEGER;
```

and accordingly, prodlist[jan] would refer to January production, while prodlist[feb] would refer to February production and so forth.

In an analogous fashion, an "array of arrays" could be used to store monthly production data for a series of products and be declared in Cobol:

```
01 YEAR-PROD.
   02 PRODUCT OCCURS 6 TIMES.
      03 MONTH OCCURS 12 TIMES
         PICTURE 9(5).
```

The same structure in Pascal is:

```
TYPE
   product =
      (blend,bourbon,gin,rye,scotch,
      vodka);
   month =
      (jan,feb,mar,apr,may,jun,jul,
      aug,sep,oct,nov,dec);
VAR
   yearprod:
      ARRAY[product] OF
         ARRAY[month] OF INTEGER;
```

The actual Pascal array definition can also be simplified as:

```
VAR
   yearprod:
      ARRAY[product,month] OF INTEGER;
```

The advantage of the Pascal approach is practically obvious. For example, the May production of gin would be referenced in Pascal as ≪yearprod[gin,may]≫ whereas in Cobol, the programmer and the "reader of the program" would have to know gin is the third product and May is the fifth month and then reference the same data as MONTH (3,5).

The way to every Cobol programmer's heart is an efficient and effective means of defining record structures. A record definition like:

```
01 PART-DATA.
   02 PART-NUM      PICTURE 9(4).
   02 PART-ID       PICTURE X(12).
   02 P-QUANTITY    PICTURE 9(7).
   02 ORDER-LEVEL   PICTURE 9(7).
```

in Pascal record structure is:

```
VAR
   partdata:
      RECORD
         partnum:
            INTEGER;
         partid:
            PACKED ARRAY[1 . . 12] OF
               CHAR;
         pquantity,
         orderlevel:
            INTEGER
      END;
```

Qualification of data names is similar in concept, if not in syntax. In Cobol, one would write PART-ID IN PART-DATA, whereas in Pascal, the equivalent qualification would be ≪partdata.partid≫.

The rules for defining record structures are applied systematically in both Cobol and Pascal to derive nest-

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"The Pascal language incorporates a special statement to avoid writing lengthy qualified data names."

ed records. If, for example, one would define a nested structure in Cobol, such as:

```
01 P-REC.
   02 E-NUM          PICTURE 9(5).
   02 NAME.
      03 FI          PICTURE X.
      03 MI          PICTURE X.
      03 LAST        PICTURE X(15).
   02 DEPT           PICTURE X(4).
```

the equivalent Pascal record structure would be:

```
VAR
  prec:
    RECORD
      enum:
        INTEGER;
      name:
        RECORD
          fi:
            CHAR;
          mi:
            CHAR;
          last:
            PACKED ARRAY[1 . . 15] OF
              CHAR
        END;
      dept:
        PACKED ARRAY[1 . . 4] OF CHAR
    END;
```

Whereas Cobol qualification would take the form FI IN NAME IN P-REC, the equivalent Pascal qualification would be ≪prec,name,fi≫.

The Pascal language incorporates a special statement to avoid writing lengthy qualified data names. One could, for example, perform a series of assignments through the use of global qualifications, as in:

```
WITH prec,name DO
  BEGIN
    enum := 449795;
    mi := 'Z'
  END
```

As with Cobol, levels of qualification can become necessary when several data items (i.e., group items in Cobol and record variables in Pascal) are defined with the same record structure. In Cobol, the COPY clause is used to retrieve a record definition from a library. In Pascal, a record type can be defined, such as:

```
TYPE
  regrec=RECORD
    prefix:
      CHAR;
    serial:
      INTEGER;
    class:
      (auto,truck,cycle);
    weight:
      INTEGER;
    color:
      PACKED ARRAY[1 . . 10] OF CHAR
        END;
```

and subsequently used in a variety of semantic contexts, such as:

```
VAR
  carid,
  billset:
    regrec;
```

and as:

```
VAR
  family:
    ARRAY[1 . . 5] OF regrec;
```

In the latter example, we have effectively defined an array of records.

Within the context of traditional business programming, the control structures in Cobol and Pascal are fairly similar. A standard method of comparison, therefore, is the manner in which they support conventional structured programming control structures.

The ifthenelse, dowwhile and dountil control structures are given in Figure 3 on Page 110 for easy reference.

• **Ifthenelse.**

The ifthenelse function provides a conditional facility that includes two subfunctions in its definition. In Cobol, the programmer would write:

```
IF p
   code for F1
ELSE
   code for F2
```

whereas in Pascal, the same structure would be expressed as:

```
IF p THEN
   code for F1
ELSE
   code for F2
```

In both Cobol and Pascal, functions F1 and F2 can represent complex statement sequences. A typical example in Cobol would be:

```
IF HOURS>40
   COMPUTE GROSS=HOURS * RATE
ELSE
   COMPUTE GROSS=40*RATE+
                 (HOURS-40)
                 +RATE*1.5
```

and the same statement is written in Pascal as:

```
IF hours>40 THEN
   gross := hours * rate
ELSE
   gross := 40*rate+(hours-40)*rate*1.5
```

Clearly, Pascal does not offer a significant advantage over Cobol in this regard.

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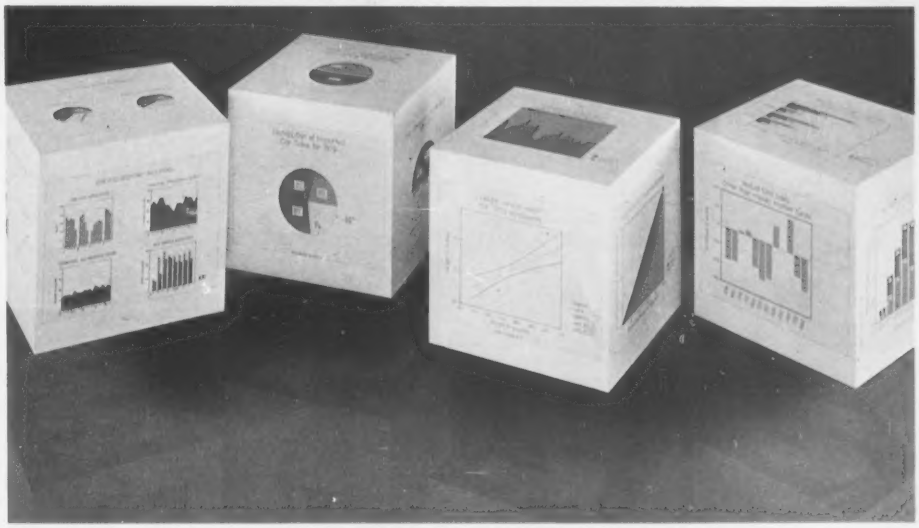

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Pascal

• **Dowhile.**
The dowhile function executes a function while a conditional test is true. In Cobol, the programmer would write:

```
PERFORM paragraph-F UNTIL (NOT p)
```

whereas in Pascal, the same structure would be expressed as:

```
WHILE p DO
  code for F
```

A typical example in Cobol would be:

```
P1. PERFORM P2 UNTIL (EXP=0).
    GOTO P3.
P2. COMPUTE XN = XN * X.
    COMPUTE EXP = EXP - 1.
P3. . . .
```

and the same example in Pascal would be:

```
WHILE exp>0 DO
  BEGIN
    xn := xn* x
    exp := exp - 1
  END
```

The key difference between Cobol and Pascal on the dowhile and dountil structures is that Cobol requires an "out of line" block for the PERFORM statement and Pascal uses an "in line" block, known as a compound statement. The key issue here is that undesirable side effects can easily influence the result of the "out of line" block in Cobol. If one were to employ segmentation with Pascal and use procedures to represent the block, then well-defined module interfaces would naturally be established to prevent side effects.

• **Dountil.**
The dountil function executes a function until a conditional test becomes true. It clearly differs from the dowhile because the logic is complemented and the function is always executed at least once. In Cobol, the programmer would write:

```
PERFORM paragraph-F.
PERFORM paragraph-F UNTIL (p).
```

whereas in Pascal, the same structure would be expressed as:

```
REPEAT
  code for F
UNTIL p
```

A typical example in Cobol would be:

```
P4. PERFORM P5.
    PERFORM P5 UNTIL (VALUE=KEY).
    GO TO P6.
P5. READ F.
P6. . . .
```

and its equivalent in Pascal is:

```
REPEAT
  READ(f1 value)
UNTIL value=key
```

The significance of eliminating potentially undesirable side effects from control structures was covered previously. It is important to note that even though the structure of programs in Pascal is notably rigid, the language does contain the necessary control structures to represent an algorithm in a perfectly natural manner. Two other control facilities are important in writing Pascal programs: the CASE statement, including in Figure 2, and the FOR statement, used for controlled looping.

Pascal was designed around the notion of a sequential file structure and a typical execution sequence to read an element from a file is:

```
r := f↑;
GET(f)
```

where ≪f↑≫ is used to reference a file element, ≪r≫ is the receiving variable, and ≪GET(f)≫ moves the file pointer to the next element. (In this case, ≪f≫ is the declared name of the file.) In an analogous fashion, an execution sequence to write an element to a file is:

```
f↑ := r;
PUT(f)
```

where ≪f↑≫ is used for file assignment in this case, ≪r≫ is the sending element, while ≪UT(f)≫ moves the file pointer to the next position.

Several implementations of Pascal, such as UCSD Pascal, have implemented procedures to facilitate file accessing. A typical procedure reference to read a file is:

```
READ(f,r)
```

where ≪f≫ is the file name and ≪r≫ is the receiving element. Similarly, a typical procedure reference to write a file is:

```
WRITE(f,r)
```

where ≪f≫ is the file name and ≪r≫ is the sending element. It follows that a corresponding procedure existing for disk positions would take the form:

```
SEEK(f,recnum)
```

where ≪f≫ is the file name and ≪recnum≫ is the relative record number.

A typical file definition in Pascal would take the form:

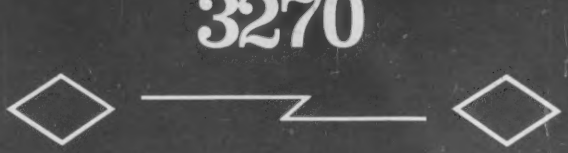
```
TYPE
  mastrec=
    RECORD
      .
      .
      .
    END;
VAR
  mastfile:
    FILE OF mastrec;
```

Clearly, a file may be a "file of" any previously defined or basic type.

Pascal is a special language for a special class of computer applications. For sure, it is not everyone's cup of tea. It will neither change the face of data processing nor will it result in an overthrow of Cobol.

But there is an unlabeled class of applications that span the gap between scientific computing and data processing and that require an algorithmic language with considerable expressive power. For these applications, Pascal is the answer.

Katzan is founder of Katzan International Computer Consulting, Inc., a Freehold, N.J.-based firm. ◆



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Alternatives to Cobol: BASIC

```
      COBOL IMPLEMENTATION                    BASIC IMPLEMENTATION
IDENTIFICATION DIVISION.                  10   REM VECTOR FILL
PROGRAM-ID.  VECTORFIL.                   20   DIM A(5)
ENVIRONMENT DIVISION.                          o
DATA DIVISION.                                 o
WORKING-STORAGE SECTION.                       o
01 A-VECTOR       PIC 9  OCCURS 5 TIMES.   ( some processing occurs
PROCEDURE DIVISION.                          which may or may not
( some processing occurs which may or        affect the values of A )
 may not affect the values of A-VECTOR )           o
IF A-VECTOR(1) NOT = 1                    300  IF A(1) < > 1
     PERFORM                                     THEN FOR NO = 1 TO 5
          VARYING NUMBER FROM 1 BY 1             : A(NO) = 1: NEXT NO
               UNTIL NUMBER > 5                  : PRINT "VECTOR A IS
          MOVE 1 TO A-VECTOR(NUMBER)             INITIALIZED"
     END-PERFORM                          400  END
     DISPLAY "VECTOR A IS INITIALIZED".
STOP RUN.
```

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(Continued from Page 97)

routine is then ready to be loaded into storage and run.

An interpreter translates the high-level code into machine language as it goes along and performs the processing indicated.

The old definition for problem-oriented languages is that they are languages designed for a specific class of problems, such as scientific or commercial problems. They are sometimes referred to as procedural languages to differentiate them from languages in which a problem is stated and the computer chooses the procedure to solve it. An example of the latter is the Coordinated Geometry (Cogo) program, designed for use in civil engineering applications.

A conversational language is one in which a near-English character set facilitates dialogue between the user and the computer. The term conversational mode refers to real-time man-machine communications via remote terminals.

Definitions and History

Cobol is an acronym for Common Business-Oriented Language. It was developed by a national committee called the Conference on Data Systems Languages (Codasyl), made up of computer manufacturers, the federal government and users.

Work began on developing a suitable language for commercial (as opposed to scientific) applications in 1959. The report of the committee issued in April 1960 contained specifications for the first version of Cobol, Cobol-60. Subsequent revisions have been issued periodically.

Although it is maintained by Codasyl, Cobol has been adopted as a standard language by the American National Standards Institute (Ansi). It has several levels of complexity in recognition of the differing capabilities of various machines on which it might be implemented. The latest version is 1974 Ansi Cobol (also sometimes referred to as ANS Cobol).

Cobol is almost universally compiled. It is a procedural computer language widely used for solving business data processing problems. Using English-like statements, its procedural construction takes advantage of commonly understood nouns, verbs and connectives to put together easily understood sentences. The combination of its rigid controls and long-length variable-naming conventions is intended to make it somewhat self-documenting. It has particularly good facilities for file handling and report generation.

Basic is an acronym for Beginners' All-Purpose Symbolic Instruction Code. It was developed in 1965 at Dartmouth College by John G. Kemeny and Thomas E. Kurtz. Ansi has developed a standard Basic to take its place beside such other standardized languages as Cobol and Fortran. It is a procedural computer language suited particularly well for time-sharing. It is interactive and conversational. Somewhat Fortran-like, it is a mathematical-type language incorporating English language conventions.

It is probably one of the easiest computer programming languages to learn and master. An individual from the engineering sciences, for example, could learn it and begin using it within a few hours. For the lay person with no knowledge of programming it could be assimilated in several days. Half the Basic translators are interpreters and half are compilers. Some even allow for both.

It is suitable for both business and scientific applications, hence its name All-Purpose. Business-oriented programs such as accounting and stock portfolio analysis are equally at home with Basic, thus the power of the language.

Usual Environment

Cobol tends to be used by companies with technical support groups, usually consisting of programmers and analysts, who operate under a centralized department and for applications consisting of commercial business problems. These are trained professionals whose duties are not often diluted by responsibilities outside the world of computing.

The systems on which they operate tend to be large mainframes. The applications may require both batch and on-line implementations. Many of them require a fair amount of maintenance programming modifications.

In addition, the applications may require interfacing with certain systems that provide special processing and that are compatible with Cobol.

Such systems as Customer Information Control Systems (CICS), which is a transaction processor, and Total, which is a data base management System (DBMS), are examples. These types of systems extend the power of Cobol by permitting calls to them via command-level statements or by macro-level calls.

Basic, on the other hand, is often found in the smaller shops or in the large company that is decentralized. It is often the choice for the first-time user of computer-based systems. In this environment, we often find an abundance of minicomputers and even the popular new arrival, the microcomputer.

The applications tend to be on-line, requiring a high degree of interaction with the user and tend to have either a business or scientific focus. Sometimes the programmers are the actual users. Programming may not be their full-time responsibilities.

Choosing a Language

Four points should be examined when selecting a particular language:

- Availability.
- Comprehensiveness.
- Ease of learning.
- Ease of coding.

By *availability*, I mean whether your particular computer system can support applications coded in the language — and do so within reasonable cost for your installation's budget. It is the combination of these factors that often inhibits the small

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Alternatives to Cobol: BASIC

computer user and points to the selection of Basic because it is inexpensive and readily available.

In addition, Basic also has been configured in read-only memory (ROM) for a number of systems. This has the advantage of reducing the amount of computer storage used by a translator and makes it available for application programs. Cobol systems tend to be significantly more expensive than Basic systems.

The second point, *comprehensiveness*, refers to the ability of the language to solve your problems by containing all of those elements necessary to do so. It would not be a good idea to use Cobol to do a lot of number crunching. Likewise, Cobol might be chosen over Basic for doing a lot of file handling.

Ease of learning might be an important consideration in a situation where the programming staff is home-grown. Training programs are costly. Ideally, the budding programmer must be made productive as rapidly as possible.

Ease of coding is pertinent in all situations. If the language is bogged down with a lot of rules, it may make coding tedious and difficult.

Cobol receives high marks because it is said to be self-documenting. It is also touted for its so-called portability — the ability to implement the code on any machine. If one were to restrict oneself to using the minimum standard for Ansi Cobol, then this last statement might be true. However, each originator of a Cobol system adds on what are known as extensions to the language to take advantage of particular characteristics of the destination machine on which the system is to run.

Thus, even within companies like Digital Equipment Corp., there is uncomfortable incompatibility between the Cobol implemented for the Decsystem-10 and the newer VAX-11/780. It is, however, unreasonable to expect that developers of the newer Cobol systems (after 1974) would restrict themselves to the limitations of a language that was not geared for a high level of on-line use. The 1980 standard, when it is released, should alleviate this condition.

As far as the self-documenting aspect goes, it is certainly there. In conjunction with structured techniques, it offers an excellent means of providing lucid code. Unfortunately, we all know that one is inclined to do the least amount of work possible to set a job done and so the area of documentation suffers.

Recently I reviewed several systems for a client. Each of these consisted of about 65 modules primarily coded in Cobol. There was very little external documentation for any of these programs. Much to my dismay, the programs themselves were terse and lacked remarks and comments. The variable names chosen were often around eight characters long (Cobol supports 32-character names) with ambiguous or totally obscure meanings. They were a study in cryptography. It all boils down to the fact that the documentation of a program does not depend on the programming language, but on the self-discipline of the programmer to document.

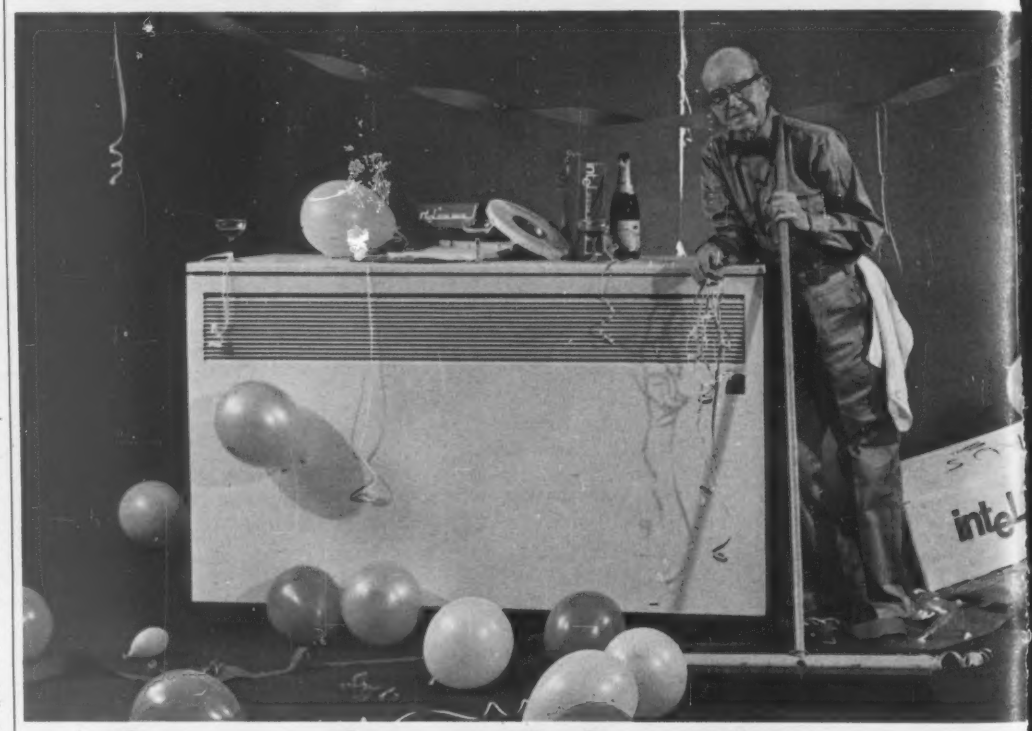
Cobol is not a simple language to learn. It requires a rigid application of rules and a demanding conformity to them. Many were the times that I spent reviewing a programmer's code trying to isolate a bus only to find it attributable to a missing period that resulted in the execution of fall-through logic, since a period in Cobol indicates the end of a particular sequence of instructions. The language has many key words and is extremely powerful. It requires a considerable period of training to master and a lot of time to become proficient in it.

Basic, on the other hand, receives high marks because it is a simple language to learn and use, and yet it is quite powerful. It is often criticized for its lack of controls. However, it is this very characteristic that permits a greater range for the programmer's creativity in problem solving. It encourages innovation. It has the same problems in portability Cobol has.

There are many versions of Basic currently available, mostly with machine-specific extensions. On the large VAX-11/780 minicomputer there is a highly extended Basic implementation language which, when used in its compilation mode, generates native-mode object modules. These modules have extremely fast execution times that compare favorably with those of unoptimized Fortran modules. Program sizes of up to two billion bytes are allowed.

There is no current Ansi standard Basic that even comes close to the power and extensions offered by this Basic.

There is also a Basic translator utility to ease conversion from Basic-Plus



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(for the PDP-11) to the VAX-11 Basic.

Four different Basic processors are available for microcomputers: Integer Basic and Applesoft-II, which run under the Apple 6502 microprocessor and CBasic and GBasic, which run under CP/M's Z80-based operating system. They all have different features, so I can select the one that is best suited for a particular application.

Another feature that many Basics have is the ability to generate graphics easily. Since so much of computer output is an attempt to present information clearly and concisely, a good graphics representation can reduce greatly the amount of paper flow and get the point across succinctly.

Some Basic programs run much more slowly than a comparable program in Cobol because they have been implemented using an interpreter. As noted above, a good Basic compiler can produce machine code that runs very fast. Speed also is relative. If an interpreted program runs in two minutes while a compiled one runs in half a minute, does it not then become a function of the environment whether the time difference is sign'ficant?

There are two different modes in which Basic commands can be executed. Immediate execution mode allows a command to be entered — such as PRINT 33/6. The computer responds immediately with the answer 5.5. This is reminiscent of how a calculator works. By the same token several instructions could be entered, such as:

```
X = 33
PRINT X/6
```

After the first line is entered, the computer makes no apparent response. When the second line is entered, the computer immediately replies with the answer 5.5. This represents the most primitive way to step through an algorithm to check its accuracy. The other mode, deferred execution, is generally implemented by identifying each command contained in a line or statement or series of statements by a specific line number. These commands may be entered in any order relative to line number and then RUN as many times as desired.

Various ways of representing data are possible. In the example above, a variable X is assigned the value 33. The answer is returned as a real variable — it has decimal precision. Other variable representations in Basic are interests that are whole positive or negative numbers, strings that are lists of alphanumeric characters and hexadecimal or octal numbers.

The first three types may be dimensioned or subscripted as vectors or arrays. The number of dimensions supported by a particular Basic varies. For instance, Basic-Plus allows only two dimensions, while Applesoft-II permits up to 88. It is possible to perform manipulations on strings converting them from one form of variable representation to another. For instance, if a string is defined as A$="ABC123", then the value 123 could be easily extracted from it. Strings can also be concatenated. The command X$=B$+D$ for the strings B$="Good" and D$="Morning!" results in X$="Good Morning!".

There are three types of operators. The algebraic operators of assignment, negation, exponentiation, multiplication, division, addition and subtraction may be used in the usual sense. They are indicated by the symbols =, -, ** or ↑, *, /, + and -, respectively. Then there are the relational operators of equal, not equal, less than, greater than, less than or equal, and greater than or equal which are represented as =, <> or ‡, <, >, <=, and >=. In addition, there are the logical operators of NOT, AND and OR.

Relational and logical expressions usually return the value of 1, if true, and 0, if false. They are often used to change the flow of processing based upon the truth or falsity of a particular set of conditions.

Many of the commands that follow use keywords easily indicative of their function. The input and output commands relate to directing the flow of information into and out of various peripheral devices and to the assignment of values and definition of functions. These include the keywords READ, INPUT, GET, PRINT, LET and DEF FN(X)= ... Special file handling commands such as OPEN and CLOSE are used for accessing tape and disk data files.

The commands relating to the flow of control consist of the unconditional GOTO and GOSUB commands where SUB stands for subroutine plus IF ... THEN GOTO or STOP, or RETURN, RESUME, RETURN and POP, which is an advanced programming feature that removes one address from the RETURN address tack.

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And IF . . . THEN . . . ELSE construct extends the IF statement to provide for handling the negative case of IF.

There are the looping commands of FOR X = 1 TO 5 STEP 2 . . . NEXT X, which in my example execute all statements between the FOR statement and the NEXT statement three times, stepping X in increments of 2 from 1 to 3 to 5. The WHILE and WEND (While END) structured construct allows instructions constituting a loop to be executed as long as the condition holds true.

The conditional branching command is phrased as ON X GOTO 100, 50, 700 where based on the integer value of X it goes to the appropriate statement on the list. If X equals 3, and the command is coded as stated, then the program would branch to statement number 700. The same command is applicable for GOSUB as well as GOTO. The conditional error branching is, for example, ONERR GOTO 1000.

The system and utility commands are somewhat system dependent. Most common representations are LOAD, SAVE, NEW, RUN, STOP, END, CHAIN, APPEND, EXEC, TRACE (a debugging aid, HIMEM, LOMEM, PEEK, POKE and CALL. The last five are machine-oriented. The pertain to setting memory locations.

Editing and format-related commands permit LISTing the program, DELeting lines, inserting REMarks, and utilizing various tabulation commands and screen cursor controls. The cursor is the little square of blinking light on the video terminal screen that points to the next available position for input. PRINT USING is a formatting command that allows the user to specify how and where the data is to be displayed on the output device.

Last but not least, there are the math functions such as SIN, COS, TAN, ATN, INT, RND, SGN, ABS, SQR, EXP and LOG. Some Basic systems also include the powerful MAT functions, which are the matrix algebra manipulators. For example, a matrix may be inverted with a single command, a truly terrific feature for all those statistical and operations research problems.

In addition to the aforementioned commands there is a rich repertoire of commands relating to graphics, screen color and special port controls plus methods of passing variables to programs. They are common to many Basic implementations, particularly on the microcomputers, and are extremely easy to use.

General Structure of Cobol

Cobol instructions are first coded as a program before they are recompiled, linked and then run. As mentioned earlier, the language has a rigid structure. The rules for order, indentation, name definition of data and procedures and for writing specific entries must be adhered to strictly.

The code is divided into four divisions. These divisions are, in their order of appearance, IDENTIFICATION, ENVIRONMENT, DATA and PROCEDURE. As before, I shall maintain the convention of capitalizing keywords where they occur. The first three are used to identify hardware and data. The last division defines the processing procedures. A division may be subdivided into sections, paragraphs, entry clauses or sentences which are composed of statements. This list is not intended to be exhaustive.

The data division describes data elements by levels according to their position in a hierarchy. It is possible to manipulate several variables by using just one group level name. For instance, customer data could be named CUSTOMER-MASTER, and within this group could be name, address and phone number detail named CUSTOMER-NAME, CUSTOMER-ADDRESS and CUSTOMER-PHONE-NO.

The PICTURE clause is used to describe what kind of data it is. These data specifications include 9 for numeric data, X for alphanumeric data, A for alphabetic data and repeat counts (such as X(3) which is the same as XXX), V for assumed decimal location and S for signed numbers.

There are special designations to indicate how the data is to be stored or used. The keywords for these are DISPLAY, COMPUTATIONAL OR COMP, COMP-1, COMP-2, COMP-3, COMP SYNC.

The arithmetic operators are indicated by the verbs ADD . . . TO . . ., COMPUTE . . . = . . ., DIVIDE . . . INTO . . . GIVING . . ., MULTIPLY . . . BY . . . GIVING and SUBTRACT . . . FROM . . . GIVING. The relational operators are LESS THAN, GREATER THAN and EQUAL TO, while the logical operators are the usual NOT, AND, and OR.

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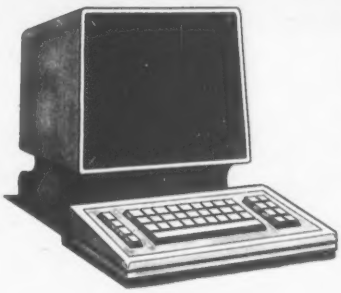

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Alternatives to Cobol: BASIC

There are many commands relating to the control of input and output. Some of these are SELECT file-name and ASSIGN TO system-device, ORGANIZATION IS SEQUENTIAL or RELATIVE or INDEXED, ACCESS MODE IS SEQUENTIAL or RANDOM or DYNAMIC, CLOSE, OPEN INPUT and OPEN OUTPUT. The record manipulation commands are READ ... RECORD INTO ..., REWRITE ... FROM ..., and WRITE.

The value assignment verb is MOVE. It copies data from one set of internal computer storage locations to another; MOVE 1 TO NUMBER.

The verbs relating to flow of control are GOTO, GOTO ... DEPENDING ON ..., and IF ... ELSE ... The PERFORM verb formats are PERFORM procedure-name and PERFORM procedure-name 1 THRU procedure-name 2 followed by optional qualifying clauses such as UNTIL or VARYING ... BY ... or n-number of TIMES.

The system and utility commands include RUN, CALL, COPY, COPY ... REPLACING ..., EXIT, and SORT. The DISPLAY verb is used to output data to a terminal device. WRITE ... AFTER ADVANCING ... is a print statement which uses format controls. The format itself is defined in the DATA DIVISION. The only resident math function is SIGN.

Comparative Implementations

The figure on Page 116 shows how a problem solution is implemented in each language. The statement of the problem is as follows: a vector A has five data elements. The value of the first item of the vector is tested for not being equal to one. If this condition is true, then all of the elements of the vector are initialized to the value of one and a message "Vector A is initialized" is displayed on the terminal output device. Some processing may occur in the program prior to the above test which need not be specified here.

The Cobol implementation takes advantage of an extension to the Ansi Cobol X3.23-1974 language by using an in-line PERFORM statement. The Basic construction allows multiple instructions to be identified by a single line number, namely, 300, while colons separate or act as delimiters between the instructions. The Cobol solution is clearly more verbose than the Basic one but not necessarily more self-documenting. If you had to code the solution to the problem, which language would you prefer to use?

The proportion of nonprofessional programmers and programmers who are the actual users relative to the programming population will rise significantly in the next few years. Already this phenomenon has been demonstrated by the increasing popularity of the personal computer. With the attractive pricing of the minicomputers and microcomputers and with their tremendous capabilities, many more businesses and small institutions will opt for their own computer facility and for providing desktop computers throughout their organizations.

A lot of these newcomers to computing will be impressed by the ease of using the Basic language and will not be put off by the mystique of a language such as Cobol. Even today, the children in elementary schools are becoming fluent with a computer language. Often they are introduced to the wonderful world of computing through the use of Basic.

I am reminded of a letter that was recently published in the magazine *Creative Computing*. A nine-year-old child wrote a brief article about using the Apple's computer language. I'll guess he was referring to Integer Basic. In it he was quite complimentary to its power and ease of use. I wonder what his reaction to computer programming would have been if he had first been introduced to Cobol.

The Cobol language is clearly for the professional programmer. That is not to imply that Basic is not, but that there are a lot of large mainframes out there that will continue to require the support of highly trained programmers to implement and maintain applications using Cobol.

On the other hand, as Basic languages expand to levels such as that of the VAX-11 Basic, there might well be a reason to choose Basic over Cobol principally for its efficient facility of development, which cuts application implementation times considerably, and for its wider range of possible applications. The next few years will certainly be interesting to watch as shifts in use occur in the various languages.

Stewart is a data base specialist for the Professional Services Group of Keane, Inc. in Boston. ◆

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New-Breed DPer

(Continued from Page 12)

tion, they've been exposed to different ways of life. Many have traveled abroad as part of exchange programs or on summer vacations and thus are more open-minded and knowledgeable about the world's problems.

They are no less concerned with the spiritual aspects of life than we were and many are searching outside traditional religions for answers. Their moral values *are* different from those of the old breed, perhaps because of the drug culture, women's liberation and the sexual revolution (birth control techniques that work!).

Acknowledging Our Role

Let me point out that we were once considered the mavericks. Veterans of World War II and Korea, we were in a hurry as we pursued our professional goals. Our bosses were just as concerned about us as we are about the younger generation. And one day, of course, today's new breed will be considered the old breed by the next generation.

We should also remember we ourselves created the multinational world they are now trying to live in: the jet age, the world of television and computers and today's well-known energy problems. At the same time, we provided them with an affluence during their childhoods unheard of — perhaps even undreamt of — by prior generations. We certainly should not begrudge them what we worked so hard to enable them to have.

In order to successfully manage the new breed, we first need to assess ourselves and our attitudes. First, we must acknowledge that they *are* different. Are we trying to change them — or do we accept them as they are? Are we open to new ideas? Certainly, new approaches are needed to solve people problems by providing solutions from which both groups can benefit and grow.

Our expectations need to be reasonable — according to the new breed's standards. Are we objective about individuals? Most obvious to come under scrutiny would be our attitudes toward women and minorities. But let's not forget our personal prejudices (beards, overweight, attire), which sometimes also get in the way.

Second, we need to take a fresh look at the work environment in our areas of responsibility. The new breed needs to feel involved, to participate in job planning, scheduling and assignment. Challenging, varied tasks are important to retain our good people. Job rotation and enrichment can assist us in conveying to our employees that we understand how much they value job content and the freedom to use their talent.

Career pathing for each employee is critical. So are frequent job performance victories, supervisory feedback and lots of personal attention. Promotions must come more quickly or the new breed will move on.

It is also important to treat the new breed within their own value structure. This includes keeping a low tension level and an atmosphere where the interchange of ideas is encouraged. One technique is to institute regular group meetings where common problems are discussed, thus reinforcing the concept of participatory management and a two-way flow of information.

Next, assess company policies and incentives. Are current salary ranges and working conditions in our groups equal to or better than industry standards? There are many areas that can provide fertile ground for increased loyalty and performance.

For example, analyze working hours. Perhaps your group would benefit by being paid to work overtime; this could eliminate moonlighting and subcontracting. Perhaps flextime should be considered, or a four-day week. Some companies are now permitting programmers to work at home except for group and review meetings — using a terminal for debugging and compilations. Others are establishing branch locations closer to employees' residences.

Additional types of incentives include educational programs, which encourage professionals to increase their skills (and therefore, their value to the company), cash bonuses for performance and/or applicant referrals and group investment clubs.

To foster a group feeling, many companies are sponsoring new group activities, such as tennis tournaments, ski trips and outings.

Another opportunity to increase the employee's appreciation of the company can be realized through the use of an annual recap of total company compensation, including salary, benefits, retirement contributions, training and educational costs and other indirect contributions.

Most of All

As DP managers, we are primarily resource managers and our most complex, challenging resource is our people. To be successful in promoting the highest productivity and the lowest turnover, we must be willing to open our eyes, modify our thinking and see things as they really are.

I have faith in the new breed. Just as our bosses worried about us when we stopped wearing hats — so we worry about the new breed.

But the new breed has a great deal to offer our companies. They are energetic, creative and more highly educated. They have a great appreciation of our god-given natural resources and are healthier and more athletic than we were. In addition, I think they are more honest with themselves and with us about their wants, desires and needs.

What we must do is accept the following recipe for the successful management of this new breed: mix together the ability to listen, decisiveness, empathy, encouragement and guidance, fairness, a personal interest, a willingness to change our ideas and prejudices and apply the wisdom of Solomon!

Gottfried is president of Gottfried Consultants, Inc., a management consulting firm headquartered in Los Angeles. ◆

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Interview With McCracken

(Continued from Page 22)

standard before there was any experience in using a programming language, and it's an act of great faith to assume what the end result will be, especially with a language as "big" as Ada.

There has been a lot of argument about the lack of upward compatibility between Cobol-74 and the proposed Ansi standard. Will that incompatibility have a seriously negative effect in DP shops?

Yes, if it happens that way. I would make an uninformed guess that when all of the shouting is done and gone, it probably *will be upward-compatible.* The alternative will be intense resistance. It's a shame it's so difficult to delete bad features from a language. But people have old programs around that include those features and they can't stand the penalty for having compiler support dropped.

The argument for upward compatibility has a tremendous amount of economic weight to it.

Any prediction as to when the new standard will come out?

No. I'm not that close to the standards business. I sympathize with the difficulty of getting a consensus from so many different interest groups. There's considerable disagreement as to what would be an ideal interval between standards. If you do it too quickly and too often, everyone is in constant turmoil. If you wait too long, there is such a large accumulation of changes it doesn't even look like the same language.

Will a universal programming language ever be developed?

Absolutely not. I can't conceive of one language that would meet the needs of things as diverse as numerical analysis in engineering work, real-time on-line transaction processing and compiler writing. Any language whatsoever can in principle do all of those, but such needs are so specialized I can't imagine developing one language that would realistically handle them.

What about the future of systems and applications programmers? Are they in dead-end careers?

Not unless they're content to be in dead-end careers. People who view programming as a nine-to-five job that they don't mind too much will have the opportunity to go on much the same as they do now.

On the other hand, they certainly don't have to settle for that. The kinds of things we've talked about — like prototyping and increased end-user involvement — create a tremendous opportunity for programmers to spend more time working with the users. They might have a subspecialty in a particular application area and function as internal consultants.

Systems programmers will have all the work they can possibly handle — all as interesting as it ever was, if not more so.

Some of the biggest changes are in the direction of doing things in other ways, but that doesn't mean the old ways will be dropped — certainly not overnight and, in many cases, never.

Will the number of programmers go up in the future?

Absolutely. If there is any way to find the people, the systems programmers will increase more than applications programmers. It will all level off at some point in the

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" It makes no sense to copyright a program — which requires publication — and then claim trade secret status for it. "

distant future and the demand for applications programmers may stabilize more quickly — but even that is many years off.

Will career paths change for systems and applications programmers?

I'm not sure what they are now. In any one kind of programming, there are a lot of different options available. Whether a person chooses to emphasize the people side of the thing or to stay strictly technical and whether a person uses a solid foundation of technical knowledge to move into management or marketing — these factors affect the career path. I don't see big changes in any of that and I emphasize that there is a lot of variety.

You once expressed concern over the lack of a professional organization for business-oriented systems developers. Does that vacuum still exist?

Absolutely. It's an area all the existing professional organizations somehow miss. The [Association for Computing Machinery] ACM and the Computer Society of the [Institute of Electrical and Electronics Engineers] IEEE are very good for computer science departments in universities. ACM concentrates more on software and IEEE places more emphasis on hardware, but there is a tremendous overlap. Both societies are also geared toward people involved with scientific technical systems programming.

The [Data Processing Management Association] DPMA does a fine job for DP managers. However, I don't think the serious, career-minded Cobol programmer, for example, has a professional organization that really meets his or her needs.

It's difficult because providing the needed services doesn't carry the same reward as that enjoyed in the academic area. Academics are rewarded for publishing, perhaps to excess. But the traditional management orientation in industry does not encourage publishing. So, finding people to write the articles is a difficult problem.

What is the best method of protection for software developers?

I don't think there is any one best method. The three basic ways to protect software are copyrights, patents and trade secrets. I think we need all of them. However, there are obvious legal differences in what they cover. It makes no sense, for example, to copyright a program — which requires publication — and then claim trade secret status for it.

A patent has to be novel, useful and nonobvious. Clearly, not very many programs meet these criteria — but some do.

Then there's a choice betwen copyright and trade secret protection.

I don't understand the apparent Adapso [Association for Data Processing Service Organizations, Inc.] position that program copyrights aren't necessary because trade secret protection is available. Trade secrets certainly serve some needs, particularly those involving large mainframes and licensing software to an easily identifiable user.

Copyrights will probably be most useful in the mass marketplace. The real protection for a book is that it's cheaper to buy it than to copy it. Until software gets down into that range, which may or may not happen, about all copyright protection provides is an opportunity to go after a really flagrant violator, but that's a useful weapon.

It's a very serious problem. When someone gets a very good idea, works 90-hour weeks for six months and brings it to the market in good form, he has the right to profit from it. It should not be possible for anyone to steal it. I believe in the concept of intellectual property — which is guaranteed in the U. S. Constitution after all — but I don't understand why we shouldn't push for all three software protection methods as vigorously as possible.

What will the MIS director of the future be like?

I don't know. You tell me.

My impression is that the person who has two kinds of background — programming and an M.B.A or engineering and law, for example — has a lot going for him.

What problems besides productivity will confront information systems directors during the '80s?

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McCracken

end users. We're dealing with people in increasing numbers with less and less demand that they learn our language before they can use our services. That creates a lot of new demands on the skills of the DP person.

We'll have to know the end user's language — what their problems are and what worries them. We will have to find some way of providing service to millions and millions of people. The ways we've done it in the past clearly are not going to work.

We may eventually face the problem of saturation. We may find that some unanticipated factor will cause things to level off. That would mean dealing with the problems of a mature industry instead of a rapidly growing one. Business schools don't offer much in that area. There are a lot of case studies on how to deal with rapid growth, but not very many on how to manage a stable market.

You say computer fraud is a major concern. How can it be prevented?

You have to fall back on a combination of things, hope for the best and admit that you won't be able to stop all of it. There is no such thing as 100% security. A combination of the kinds of administrative procedures that auditors have known about for years, like requiring two signatures in critical situations, makes fraud more difficult. Guard those passwords and change them whenever a key person leaves the company. None of that is glamorous or foolproof, but it does help. I don't think there is a single solution — technical or otherwise.

Do what you can and then buy insurance.

You've said that the future is essentially unlimited and that means there is as much potential for evil as for good. What do you see as potentially evil in terms of the information processing industry?

Certain phenomena that occur when technology is introduced into complex systems offer some historical parallels as to the risks and dangers. These aren't necessarily predictions.

If you consider the emergence of the first commercially produced computer, Univac I, as a starting date, computing is only 30 years old. I think it is coming in faster than any previous technology in history.

Any new technology has unintended side effects — some of which will be negative. The production of the automobile created the suburbs, which eventually created a dependence on foreign oil. That doesn't mean Henry Ford was an evil man. I think it's safe to say that things like that will happen.

In some cases, technology creates excessive dependence. You get to a point where you can't do something because you've lost the skills to accomplish it without the technology or you're doing things in a way that would have been impossible before the new technology.

New technology tends to create increased interdependence between people. That isn't necessarily bad in itself, but the new interdependencies can be unstable for reasons that didn't previously exist.

There is the incredible involvement of computers in the military. I'm not a pacifist in the strict sense and I think we have to have a defense organization. But there are an awful lot of computers involved in it. A few times each year, apparently, computer malfunctions tell us "the Russians are coming." Luckily, nobody has believed it yet, but they might at some future point.

In addition, this country is currently in the business of selling weapons to both sides in explosive political situations. This means computers are being sent to places where the local technicians are really not up to maintaining them at all. I don't want to emphasize a scenario of how things can go wrong, but the picture appears to be destabilizing.

Another possibility would be some sort of conspiracy to take over the banking system. People write about this sort of situation in scare novels, but I haven't seen one yet that was very convincing. However, the emergence of any technology introduces factors many years later that were never anticipated.

In some areas of the country, software developers are working out of their own homes. Will "cottage programming" be a significant trend in the future?

There certainly is some kind of trend in that direction and, considering the people shortage, cottage programming is probably a reasonable option.

Software for personal computers is being written on that basis where individuals or a few people develop a package completely on their own.

However, I doubt that applications programming will be done in a big way. So much depends on talking to users, staff meetings and the like that it doesn't seem feasible.

We've covered programmers, languages and trends of the future. What do you see in Dan McCracken's future?

Essentially, more of the same. I want to keep writing books that deal with the new concepts as time goes on. It isn't my particular function to work with the absolutely latest thing in any field.

My role seems to involve popularizing concepts that are working in the real world about five years after they've been introduced and have been proven useful to a lot of people. I hope to do more of the same in the sense of presenting new things to users. I'm also interested in combining my technical work with volunteer activities like heading the Afips [American Federation of Information Processing Societies] History of Computing Committee or doing other public service work. But there are no ventures in the works at the moment. ◆

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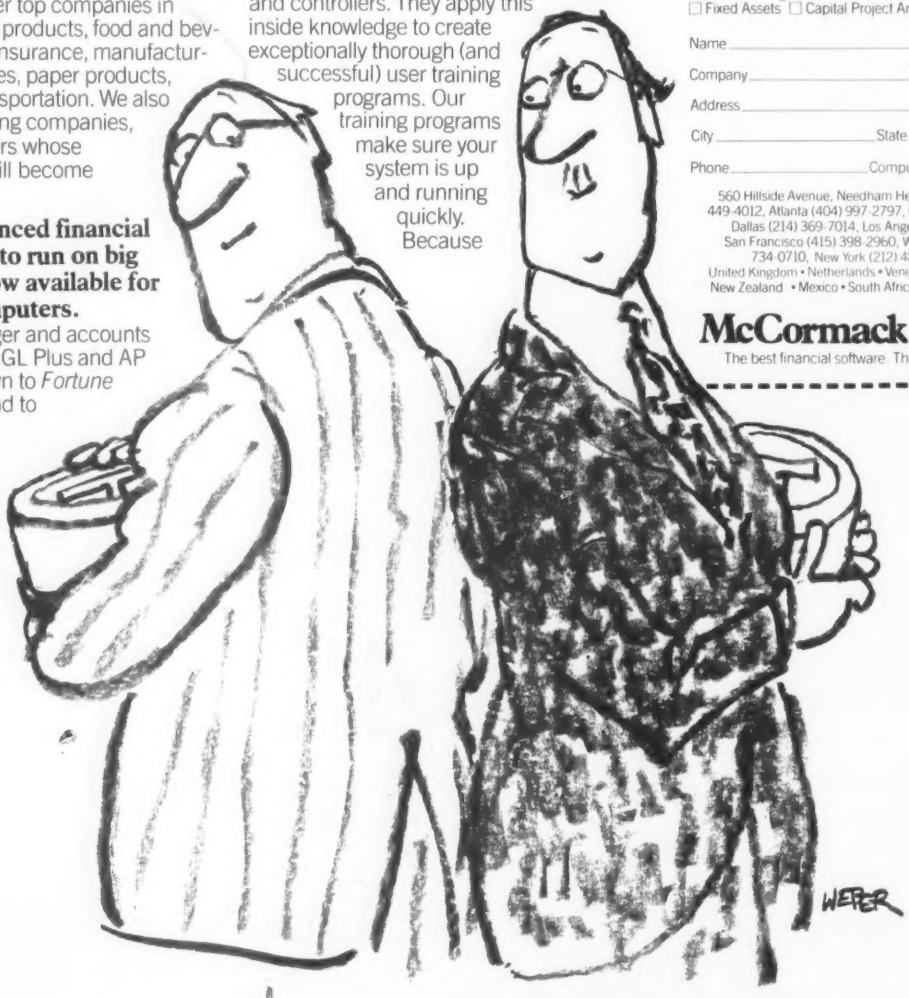

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